Civil Engineering Education

BY J. A. L. WADDELL, MA. E.

(Continued from page 3.)

Before proceeding to discuss the third, or consultation system, it will be well to define what is meant thereby. It consists essentially in laying out for the class a certain course of reading in any subject, dividing it up, if thought advisable, into daily lessons, and each day at a certain time answering any questions thereon that the students may ask.

This method often reverts naturally to the lecture system, since one question leads to another, and the professor, if properly interested in the subject, is very apt to digress and thus give the students many points that are not to be found in the text books.

Such informal lectures are far superior to those ordinarily given, for they deal only with the difficult points, and tend to show the practical application of what otherwise might appear to the students mere theory. The amount of ground that can be covered by this system is nearly double that which can be covered by the recitation system, provided that the students are all working for the sake of obtaining knowledge and not for diplomas merely. The success of the consultation system is entirely dependent upon the good faith and earnestness of purpose of the students and the practical competency of the instructor. If the latter be thoroughly posted in all the subjects he teaches, he will be able to answer readily any questions propounded by the students, and the amount of labor involved in teaching is much less by this method than by either of the others. On the contrary, if the instructor be not thoroughly posted on both the theory and practice of his subjects, the consultation system will involve for him a great deal of labor, and he will constantly be asked questions that he cannot answer.

With fairly good students the consultation system can be advantageously used in combination with the recitation system; but when the students are not of a high grade, and are endeavoring to study just enough to graduate and no more, it should not be attempted, unless the Faculty be willing to drop a large portion of the class.

The author has tried the consultation system for over three years in teaching Japanese students, and the excellence of their extended and difficult examinations gives ample proof of its thoroughness and efficiency for the higher classes. For the lower classes its advantages were not so marked; consequently in these the method has been combined with the recitation system, and occasional lectures.

Students should be taught to work together, both while studying and designing, without interfering with each other. If the class be large, it should be divided into sections, each section having a room to itself. By walking around among the students occasionally the instructor can aid them materially in their studies and designs by answering questions, pointing out faults, suggesting improvements, etc.; but in so doing he should be careful not to do too much thinking for indolent men. On this account, it is often advisable not to answer a student's question, but to tell him to study out the point for himself.

One important conclusion that the author has drawn from experience, both as a student and as an instructor, is that "to really appreciate a lecture, the hearer must be fairly well informed on the subject treated." Otherwise so many new facts and ideas will be presented to his mind that he will be unable to grasp them, and; if he attempt to make notes during the course of the lecture, he will fail to understand a large portion of the discourse. For this reason, if lectures be given to the classes on technical subjects by eminent engineers, it should be after the regular courses in these subjects are finished.

The method of supplementing practical courses by visiting engineering works either finished or in course of construction, if properly employed, is of great advantage, but such excursions are too often a farce and a mere excuse for the students to have a good time.

The best time to visit any piece of engineering is just after the class has finished studying the course which treats of such work, and just before commencing their designs. To make the visit really useful, the engineer of the work should be induced to accompany the class, and explain everything connected therewith in a systematic and detailed manner. If possible, he should show them the original plans by which the works were built, and explain the order in which the different parts were begun and finished. He should give them also, if possible, the cost of the different parts of the work, both estimated and actual.

A visit to work in course of construction is generally preferable to inspecting that which is finished.

Students should be advised to spend a portion of their summer vacations in inspecting engineering works, and it is much better to visit those works that are connected with finished studies than to try to get a practical idea of subjects before the courses thereon are begun. Students should consult with their instructors before the vacation begins as to what places it is advisable to visit, and should obtain from them, if necessary, letters of introduction to the managers or engineers of such works.

Concerning the benefits to be derived from reviewing courses before examination, there may be two opinions. Certainly it affords a more thorough drill, and in this way forces the poorer students on: but it is a question whether the time thus occupied could not often be spent to greater advantage. The adoption of the review courses or the dispensing therewith, might be left to the judgment of the instructor. If he finds that the class understands the subject at the end of the advance course, he could omit the review.

For the elementary courses, particularly those in pure mathematics and analytical mechanics, reviews are undoubtedly beneficial, because it is in these courses especially that students require thorough drill.

And now a few words as to the qualifications and duties of a professor of civil engineering and his methods of management. First as to his qualifications—he should have had a thorough course of study in,and be a graduate of, one of the leading technical schools, besides having had several years' experience in the actual practice of his profession. He should have made a special study of some particular branch of engineering and have obtained a reputation therein as an expert. He should have the capacity for readily imparting his knowledge to others, and be possessed of a certain amount of tact. His reputation, both as a man and an engineer, should be without reproach, in order to command the confidence and esteem of those whom he teaches.

A professor should endeavor to make all his courses as attractive as possible, and try to instil into the minds of his students a real taste for work, encouraging them to mental effort by occasional references to the lives of eminent engineers. He should show the practical application of everything he teaches, and avoid the use of all mathematics that are not in harmony with good practice.

He should impress upon the minds of his students that everything which is worth doing at all is worth doing well; and that, if they ever go into contracting,it will,to say the least, be the best policy to do all their work in a thorough and workmanlike manner, even if by so doing their apparent profits be lost.

A professor of a technical course, should teach his students that it is not sufficient to make a design that shall be adequately strong and fulfill all the requirements, but that it must also be made in the most economical manner. He should distinguish between true and false economy, and prove that in many cases it is not the most elaborate design that is best for the purpose, and that simplicity is generally an accompaniment of economy. He should endeavor to gain the confidence and good will of his students in every legitimate manner, but not by allowing them to have their own way, when that way is not the right one.

A professor should study the mental peculiarities of his students, and, if possible, vary his methods of teaching accordingly.

If an instructor teach a number of different subjects, he should not compel his classes to pay undue attention to the particular branch in which he is most interested, to the neglect of other subjects; nor is it fair to the students to use their time in assisting the instructor to to make original investigations. However, such a course of action is not objectionable in teaching post-graduates, provided that their chosen specialty be the same as that of the instructor.

Students should be encouraged to read the technical literature of the day; and it should be considered to be the duty of each professor to call the attention of his classes to anything in his line of work which appears in the journals, and which in his opinion the students ought to know.

If a professor have spare time from his classes (as should always be the case) he should make some practical use of it, either by original investigation, by compilation of the results of the investigations and experience of others, or by attending to a regular engineering practice of some description.

A professor should neglect no opportunity to increase his professional knowledge, and thus render his services as an instructor more valuable. It is well for him to spend at least a portion of each summer,vacation in practical work connected with the courses which he teaches. He should not feel at all satisfied with his knowledge of any of his branches, unless he can confidently answer readily any legitimate question thereon propounded by a student; even then he cannot consider himself up to the times unless he reads everything new of value as soon as published. He should at least glance over each new book connected with his work as soon as it is issued; then if it prove to be a good one, he should read it carefully through so as to give the benefit of its contents to his students either by making them read it, or, in exceptional cases, by preparing lectures therefrom.

It is almost essential for a professor of engineering to join the principal engineering societies of the country, and to become acquainted with the leading engineers. Finally, he should be posted in respect to the prices of all kinds of materials, machinery, finished structures, labor, etc., connected in any way with his courses, and he should know where the different materials may be purchased to best advantage.

Next, as to the education preliminary to a course of civil engineering, it may be stated, without fear of contradiction, that the broader and more thorough this is the better. Although Latin and Greek are almost useless to the engineer, an acquaintance with one or two mod-

ern languages is a great advantage, hardly sufficient though to make it advisable to introduce their study into the curriculum of an engineering school. If one could learn them there at all thoroughly, it would be very well to incorporate them in the course; but the fact is that the amount of knowledge so gained is not enough to warrant their study. It is often said that the engineer who cannot read French and German is at a great disadvantage, but the writer wishes to take exception to this statement, for now-a-days any work of real value in either of these languages is very soon translated into English. Moreover many of the engineering treatises in French and German are of a purely mathematical character, and are not to be compared in value to the corresponding modern works published in England and America.

The requirements for entrance into a course of civil engineering will, undoubtedly, vary with the character of the course, the time allowed for same, the finances of the institution and other considerations. In any case the entrance examination should include the following subjects, and a thorough knowledge thereof should be insisted upon by the examiners:

English. { Spelling. Grammar. Composition.

Mathematics. { Arithmetic. Algebra. Geometry.

Geography.
Book-keeping.
Elementary Physics.
Elementary Draughting.

The reason why book-keeping is inserted in the list is because a knowledge of it is necessary to a contracting engineer, and it would be out of place in the curriculum.

The best age for entering a technical school is probably eighteen, though the minimum age might be advantageously fixed at seventeen. It is a disadvantage to enter late in life, unless one has previously been accustomed to hard study.

The following is an ideal course in civil engineering, which can be given only under the most favorable circumstances. To it all others may approach by an asymptotic curve.

For entrance, in addition to the list previously given, the following subjects are to be included:

Plane and Spherical Trigonometry.
Projection Drawing.
Elementary Perspective.
Physics. { Heat. Light. Sound. } Advanced courses.
Inorganic Chemistry (Theory).
Free Hand Drawing.
English. { Rhetoric. Criticism.

FIRST YEAR SUBJECTS.

Surveying. { Chain Surveying. Compass Surveying. Transit Surveying. Direct Levelling. Indirect Levelling. Contour Surveying. Stadia Surveying.

Mathematics. { Analytic Geometry. Differential and Integral Calculus

Natural Sciences. { Descriptive Astronomy. Mineralogy. Lithology. Technical Geology. Physical Geography.

Drawing. { Plan Topography. Colored Topography. Free Hand Drawing. Descriptive Geometry (Plates). Maps for Various Surveys.

Road Making. { Common Roads and Streets. Tramways.

Descriptive Geometry (Theory).
Shades and Shadows (Elementary
Carpentry.

SECOND YEAR SUBJECTS.

Surveying. { Omnimeter Surveying. Sextant Surveying. Hdyrographical Surveying. Railroad Surveying. Canal Surveying. Sewerage Surveying. Practical Astronomy.

Mathematics. { Least Squares. Astronomy.
Machinery. { Elements of Mechanism. Machine Construction.
Drawing. { Machine Construction (Plates). Maps of Various Surveys.
Materials. { Properties of Materials. Resistance of Materials (Math).
Rational Mechanics.
Railroading.
Sanitary Engineering.
Shopwork.

THIRD YEAR SUBJECTS.

Surveying. { Geodetic Surveying. Mining Surveying.
Drawing. { Theses. Maps of Surveys. Pattern Making.
Machinery. { Machinery, Tools, etc., used on Eng. Work. Pumps.
Natural Sciences. { Electricity (Theory and Experiments). Magnetism (Theory and Experiments). Practical Chemistry.
Mechanics. { Thermodynamics. Electrodynamics.
Materials. { Metallurgy. Manufacture of Shape Iron and Steel. Foundry Work and Pattern Making. Limes, Cements and Mortars. Masonry and Brickwork.
Earthwork. { Removal of Earth. Tunneling and Rock Excavation. Well Boring.
Sub-aqueous Eng. { Tunneling. Dredging.
Timber Structures.
Mining Engineering.
Mechanical Engineering.
Electric Engineering.
Shopwork.
Writing of Technical Papers.

FOURTH YEAR SUBJECTS.

Surveying. { Bridge Survey.
Drawing. { Stone Cutting (Plates). Theses.
Machinery. { Steam Engine. Hydraulic Motors. Wind Motors.
Structures. { Bridges. Roofs. Braced Piers.
Stone cutting.
Theory of Hydraulics.
Foundations.
Architecture.
Shopwork.
Writing of Technical Papers.

FIFTH YEAR SUBJECTS.

Surveying. { Water Works.
Drawing. { Theses. Plans. Maps.
Structures. { Arches. Retaining Walls.
Hydraulics. { Water Supply. River Engineering. Canal Engineering.
Marine Engineering. { Harbors. Lighthouses. Buoys.
Shipbuilding.
Railroad Management.
Law of Contracts.
Engineering Estimates.
Management of Forces of Men.
Shopwork.
Technical Writing.

This time schedule is merely an approximation, and would have in any actual case to be changed to suit the circumstances. It is given simply to show that the courses laid out can be completed in the time allowed, and the relative amount of time to be devoted to each course. The total number of hours required is in each year less than the available sixteen hundred. The remaining hours can be employed in holding examinations, visiting engineering works, etc. Under the heading "Drawing" is not included the time necessary for making designs but, only that for making plans, maps, and plates. The time allotted for designing will be found in the "Practice" column for each subject.

In the column headed "Preparation" no night work is included, but in the second year under the heading "Practice" is included an allowance for time to be spent at night in making astronomical observations.

The hours under the combined headings "Preparation" and "Recitations or Lectures" can be used as desired under the "consultation system."

TIME SCHEDULE.

FIRST YEAR.

Subject.	Hours Required. Preparation.	Recitations or Lectures.	Practice.	Total.
Surveying	150	30	220	420
Mathematics	320	80	.....	400
Nat. Sciences	120	40	.....	160
Drawing	.....	.....	150	150
Roads, etc.	45	15	.....	60
Descr. Geom., etc.	60	30	.....	90
Carpentry	30	10	.....	40
Totals	725	215	370	1310

SECOND YEAR.

Subject.	Hours Required. Preparation.	Recitations or Lectures.	Practice.	Total.
Surveying	60	20	320	400
Mathematics	80	20	.....	100
Drawing	.....	.....	150	150
Machinery	60	20	.....	80
Materials	75	25	.....	100
Mechanics	300	75	.....	375
Railroading	60	20	.....	80
San. Eng.	60	15	.....	75
Shopwork	.....	.....	100	100
Totals	695	195	570	1460

THIRD YEAR.

Subject.	Hours Required. Preparation.	Recitations or Lectures.	Practice.	Total.
Surveying	100	25	160	285
Drawing	.....	.....	120	120
Machinery	24	8	.....	32
Nat. Sciences	60	20	250	330
Materials	90	30	.....	120
Earthwork	64	16	.....	80
Sub-aq. Eng.	24	6	.....	30
Structures	9	3	.....	12
Mining Eng.	75	25	.....	100
Mech. Eng.	75	25	.....	100
Electric Eng.	75	25	.....	100
Shopwork	.....	.....	100	100
Totals	596	183	630	1409

FOURTH YEAR.

Subject.	Hours Required. Preparation.	Recitations or Lectures.	Practice.	Total.
Surveying	.....	.....	60	60
Drawing	.....	.....	60	60
Machinery	200	50	250	500
Structures	160	40	200	400
Stone Cutting	24	6	.....	30
Hydraulics	60	15	20	95
Foundations	40	10	60	110
Architecture	45	15	.....	60
Shopwork	.....	.....	100	100
Totals	529	136	750	1415

FIFTH YEAR.

Subject.	Hours Required. Preparation.	Recitations or Lectures.	Practice.	Total.
Surveying	.....	.....	60	60
Drawing	.....	.....	40	40
Structures	48	12	50	110
Hydraulics	75	25	150	250
Marine Eng.	90	30	150	270
Shipbuilding	160	40	200	400
R. R. Management	20	10	.....	30
Contracts	15	15	.....	30
Estimates	.....	10	40	50
Management of Forces	14	6	.....	20
Shopwork	.....	.....	100	100
Totals	422	148	790	1360

The smallest staff of professors required for the forgoing ideal course, in the author's opinion, would be the following:

Professor of Geodesy and Surveying.
Professor of Mathematics and Astronomy.

Professor of Mining Engineering, Chemistry, etc.
Professor of Drawing.
Professor of Roads, etc.
Professor of Mechanical Engineering.
Professor of Structures and Materials.
Professor of Electrical Engineering.
Professor of Hydraulics and Sanitary Engineering.
Professor of Architecture.
Professor of Shipbuilding.
Lecturer on Law of Contracts and Technical Writing.

Whenever this class is very large or the work demands it, a professor should be furnished with an assistant; and in the workshops there should be enough skilled mechanics employed to obviate the necessity of relying on the students for the accomplishment of necessary work.

Students' time should not be used in the making of models, etc., for the amount of their time to be spent on any one kind of work should be just enough to teach them how to do it; any more than this is wasted.

The qualifications for an assistant are that he be a graduate of a technical school, that he have had at least two or three years' practice in work of the same kind as that with which the courses of the department are concerned, and that he be energetic, desirous of increasing his knowledge and interested in the class of work which he is required to perform.

The professor of "Geodesy and Surveying" would take all the surveying courses of the first year, omnimeter, sextant, hydrographical and canal surveying in the second year, and geodesy in the third year; and would give both the theory and practice in these subjects. The professor of "Mathematics and Astronomy" would take the courses in analytic geometry, calculus, rational mechanics, descriptive astronomy and practical astronomy. The professor of "Mining Engineering" would take the courses in mineralogy, lithology, technical geology, physical geography, practical chemistry (including blow-pipe analysis) in addition to mining engineering and surveying. The professor of "Drawing" would take all the drawing of the first year and the courses in descriptive geometry (including shades and shadows) and stone cutting. He might also be associated with the professor of "Surveying" so as to take charge of some, if not all, of the drawing of that department. He should be required to pass judgment upon the mechanical execution of the drawings for designs in the other departments.

The professor of "Roads, etc.," would take the courses in common roads and streets tramways, railroading (theory and surveying), earthwork, tunneling, well-boring, dredging, railway management, estimates, and the management of forces of men.

The professor of "Mechanical Engineering" would take all the courses in machinery, excepting hydraulic and wind motors, and the courses in shopwork, foundry work and mechanical engineering.

The professor of "Structures and Materials" would take all the courses in structures, and all those in materials except foundry work, also the course in foundations.

The professor of "Electrical Engineering" would take the courses in electricity, magnetism, thermodynamics, electro-dynamics and electrical engineering.

The professor of "Hydraulics and Sanitary Engineering" would take all the courses in hydraulics, marine engineering, sanitary engineering and those in hydraulic and wind motors.

The professor of "Architecture" would take the courses in architecture and carpentry.

The professor of "Shipbuilding" would have only that one course.

The lecturer on law of contracts should also act as professor of English, giving occasional lectures (not included in the time schedule) on subjects connected with technical writing, and revising all these in respect to their literary character. A legal gentleman connected with the patent office, who would competently fill this chair, could readily be found. His work in the institution need occupy but a short portion of his time.

At the end of five years' course a lecture of advice to the graduating class delivered by some prominent member of the profession would be of great value to the young engineers.

The author will now make a few remarks as to how certain courses ought to be taught. In some of the courses he has had a good deal of experience and consequently feels competent to speak thereon, in others he has had but little, and in still others none at all. It is this portion of the paper especially that he wishes to see thoroughly discussed.

The various courses in surveying should be thoroughly taught by text books (or failing these by lecturers), and sufficient field work should be given to accustom each student to the use and adjustments of all instruments and to acquaint him with the objects and *modus operandi* of each kind of survey. The location for the survey should be chosen so as to make evident its use, and the instructor should endeavor to organize his classes for field work in the same thorough manner as he would for an actual survey in practice. Strict discipline should be maintained in the field, and the students should be taught to obey orders as quickly and faithfully as if their positions depended upon their so doing. In short, all the operations in the field should be conducted in exactly the same manner as in engineering practice. The instructor should never employ old methods of surveying when new and better ones have come into use. Some of the latest and best methods can be found described in engineering journals and pamphlets only.

The keeping of notes is one of the most important points in surveying. The instructor should first ascertain the best method for each kind of survey, then explain it clearly to the students, and see that it, and no other be scrupulously followed.

The instructor should acquaint himself with all the new instruments used in surveying, paying special attention to their adjustments, and should practice using them until they become as familiar to him as are the transit and level. He should then see that the students become as well acquainted with them as he is.

Concerning the best method of teaching the course in geodesy, and the necessary amount of practice therein, the author does not feel competent to speak, having had no practice in that subject. The facilities for field work in giving this course are generally very poor; but the author would imagine that a small amount of practice in base line measurement could always be given, also practice in the measurement of a few angles of large triangles. For computations, the field notes of coast surveys might be taken. The class should have instruction by actual practice in all the calculations connected with a geodetic survey.

The courses in pure mathematics should be most thoroughly taught, and the instructor should explain the applications of the various formulæ, etc., as the course progresses. The course in calculus is generally given in such a blind manner that few students after finishing it know anything more about it than simply how to differentiate and integrate. They have no conception of the real meaning of partial and total differentials; and they could not possibly discuss a curve as given by the equation. If, during a purely mathematical course, the students be shown a little of the practical application of what they are learning, they will study with greater interest.

The subject of least squares should be taught both theoretically and practically, following the method given by Prof. Mansfield Merriman.

The amount of astronomy that an engineering student needs is not great, and the mathematical and instrumental portions of the course should be restricted to such investigations and manipulations as an engineer may be required to make.

The natural science courses of the first year should be of an elementary character, but those in the third year should be more thorough. The instructor should not forget the fact that it is not a class of physicists which he is instructing, but one of engineers.

The courses in drawing should occupy no more time than is necessary to give the students a reasonable amount of skill in the manipulation of the instruments. It is a mistake to spend much time on fancy shaded drawings, as in the last few years blue prints have driven elaborate drawings out of the field. The drawing department should be furnished with all the apparatus for making blue prints and similar copies of drawings, and each student should be thoroughly drilled in its use.

Pen topography appears to be a great waste of time, and it is to be hoped that the new mechanical method will soon supersede the old and laborious hand process. Meanwhile, probably, it is necessary to teach a certain amount of it in engineering courses.

Maps and plans should be always made in the most approved, practical manner.

The course in descriptive geometry should be thorough, as the mental discipline thereby acquired is of a peculiar kind and very valuable; moreover without a thorough instruction in this subject one would be unable to make some of the most difficult drawings that are required in engineering practice. But the portion of the course which deals with shades and shadows need not be very elaborate, because in these busy days there is no time for an engineer to indulge in such luxuries as shaded drawings with shadows. For the same reason no time should be wasted in the study of the higher linear perspective, the amount required for the entrance examination being sufficient for all practical purposes.

The instruction in the course in railroading should comprise all the operations of exploration, preliminary, location, construction and maintenance, together with descriptions, by means of blue prints or other drawings, of rolling stock, station houses, tanks, trestles, culverts, etc., etc. After each student has had a little practice in laying out the various kinds of curves, borrow-pits, drains, slope-stakes, grade-plugs, etc., a couple of suitable points should be chosen, say five miles apart, preliminary lines be run between them, a location be projected on paper, then run in on the ground, and finally the whole work be completely laid out so that workmen could commence upon any number of parts of it at once. All the operations that would be performed by the section engineers in actual practice should be performed by the class, and each student should do enough of each kind of work to enable him to repeat the operations whenever occasion may require. Few, if any, engineering institutions give a proper

course in railroad surveying; consequently when a graduate first goes on a section he feels like a fish out of water, and is a laughing stock for the older hands. In this respect the author can speak from experience, having had to take charge of a section at the beginning of his professional career. Among other instructions he was told to drive grade plugs for a cutting, and it was the first time he had heard of such a thing as a grade plug. By a fortunate guess and by exercising a little common sense he managed to drive the plugs without exposing his ignorance.

Canal surveying should be taught in a similar manner to railroad surveying, and with as much thoroughness.

The courses in materials should be very extended, thorough and practical. It is well to begin with an elementary work like Merriman's, then pass to a larger treatise such as Burr's, but omitting from the latter all the mathematical work. Then take a mathematical treatise such as Wood's and investigate the actions of bars, beams and columns under the various kinds of loading, returning afterwards to Burr's work for a more extended mathematical investigation.

The course in rational mechanics should be given just as thoroughly as are the courses in pure mathematics. Great stress should be laid upon the students understanding clearly the fundamental and derived units and their interdependence. There is no satisfactory text book for giving this course, but those lately written show a decided improvement upon the old ones. The course may be most advantageously given, partly by lectures and partly by using text books, Rankine's Applied Mechanics being relied on for the principal investigations.

The course in sanitary engineering should be given from text books such as Latham's Sanitary Engineering, and the works of Waring, Philbrick, etc., supplemented by lectures which should comprise, among other things, deductions from the discussions on sanitary matters that have lately appeared in the technical papers.

In the shops the students should be taught to perform the most common operations in blacksmithing and carpentry, also the use of the lathe and machine tools; and the instructor in mechanical engineering should bear in mind that he is teaching *civil*, not mechanical, engineering students.

The course in mining engineering should be short but complete, the object being to fit the students to take charge of the surveying and management of ordinary mines. If possible some time should be spent in making an underground survey. Unfortunately there is no good text book upon mine surveying in the English language, therefore that part of the course must be given by lectures.

After completing the course in steam engines each student should be required to make a design for a small, simple engine, and prepare all the working drawings and estimate of cost. Similar designs should be required in the courses in hydraulic motors, bridges, foundations, arches and ship-building.

The only fit text book for the course in hydraulic motors is that of Weisbach, but in respect to the proportioning of parts it is very crude, so that the course in this particular will need supplementing by lectures. The best text book for the course in wind motors is Wolff's. It is not necessary to make a design in this course, because wind-mills of any desired size can be ordered from the manufacturers without sending a single drawing or making a single calculation; and the chances that any member of the class will act as engineer for a wind-mill company are very small.

The course in bridges is an important one and is seldom properly given. The idea of most instructors appears to be that if they teach how to calculate the stresses in the main members in a truss, their duty is accomplished, whereas they have merely taken the first step. They should teach not only how to calculate every direct and indirect stress on every part of a bridge, but how to proportion all the parts to resist these stresses. A thorough instruction in bridge designing will greatly simplify for the students the courses in roofs, braced piers, and shipbuilding. It would be well to omit from the course all notice of those styles of bridges which have been disapproved by the leading modern American engineers, and no time should be wasted in figuring stresses in continuous spans other than swing bridges. In addition to the ordinary types the course should include suspension and swing bridges, also cantilevers; and the students should be required to read a number of monographs of existing structures, for instance those of the Bismarck, Plattsmouth, and Niagara Cantilever, bridges.

The course in the theory of hydraulics should be both thorough and practical, and all antiquated formulæ should be dropped therefrom. Numerous examples for solution should be given the students in this course. Indeed in all the purely technical courses as many examples should be given for solution as time will permit.

The course in foundations can be given most advantageously by the consultation system, the student being required to read carefully everything of value in the English language upon the subject. In choosing a design in this course the instructor should be careful not to make the work too long or too difficult.

The course in architecture should be of a somewhat elementary character.

After completing the courses in water supply and sanitary engineering, surveys of a small town should be made under the supposition that it is to be supplied with water and sewerage; plans should then be prepared, and detailed estimates of the cost be made out in the manner usually followed in actual practice when preparing to let contracts.

In giving the course in river engineering, special attention should be paid to the tried and proposed methods of improving the great rivers of America, and protecting the adjoining lands from floods. The course in harbors will be necessarily descriptive.

The course in shipbuilding, though not occupying a very long time, should be complete; and special attention should be paid to details and the proportioning of parts to resist calculated stresses.

The course in law of contracts must of necessity be merely elementary, still it should be sufficient to enable the members of the class to prepare any forms of contract that will be needed in engineering practice.

In any course whenever models can be advantageously employed as aids in instruction, they should be provided and used. Moreover they should be intelligently designed and properly manufactured, for an incorrect model will have a prejudicial effect upon students' minds instead of being an aid to understanding.

Students should be encouraged to take exercise; but excess therein should be avoided for two reasons: first, there is always a tendency to overdo such sports as foot-ball, rowing, racing, etc., thereby losing instead of gaining health; and second, there is usually a great deal of time wasted. For instance, in rowing it generally takes quite a while to get to and from the boat house; and base ball matches require a great deal of practice and occasional excursions to neighboring towns and colleges. For good, healthy exercise that is not liable to be overdone and that requires the minimum loss of time from work, affording at the same time plenty of amusement, there is no out-of-door sport that can be compared to lawn tennis; and if the grounds belonging to and surrounding the institution be laid out into tennis courts and maintained in good order at the expense of the institution, it is highly improbable that the students' health will suffer from lack of exercise. If the grounds be large enough, spaces for base ball and foot ball might also be allotted.

A gymnasium is a useful adjunct to an institution of learning, and room might be provided therein for private instructors to give lessons in fencing, boxing, etc., to those who have the time, money and inclination for such pastimes. Students should be encouraged and taught to look upon the taking of exercise as a necessity for health; but it must be remembered that, unless the exercise be presented in an attractive form, few will have the moral courage to take it.

Technical degrees are not looked upon with the proper amount of respect by the world at large. This is due to two reasons; first, there is no law to prevent any man from tacking a C. E. or an M. E. to his name, consequently it is no uncommon practice for rodmen, surveyors, and mechanics to thus dub themselves engineers; and second, there are too many low-grade colleges in the United States giving engineering degrees without a proper engineering education. The institution which would give the ideal course previously described might obtain legislative permission to have the sole right to confer the following degrees, viz.: B. C. E. (Bachelor of Civil Engineering) to the members of its graduating classes, M. C. E. (Master of Civil Engineering) to graduates who have had five years' practice and who have passed a rigid examination upon some special branch of engineering optional with them, and the honorary degree of D. C. E. (Doctor of Civil Engineering) to those graduates who have distinguished themselves in their profession.

The trustees or managers of this institution should give all the encouragement and aid that lie in their power, to promote original research by the professors and assistants. They should see that the institution be properly provided with an abundance of good books, drawings and models, and they should encourage the formation and maintenance of scientific societies connected with the institution.

The officers of the institution should not exercise any control over students, except when the latter are within the precincts of the institution, or in cases of grave offences against either the law or individual welfare; and no religious exercise of any kind should form a part of the curriculum.

(THE END).

THE distinguished Antwerp chemist, Professor Kemna, has found that in the case of bad water, a double purification is possible, the water being twice passed through the revolver and twice sand filtered. The results, in the case of Ostend, are given in the table. In his capacity as consulting chemist to the Antwerp water-works, Mr. Kemna has devoted much time and research to the process, and both he and Mr. Devonshire, the resident engineer, have made many useful investigations and suggestions. The cost of applying this method of purification depends, of course, upon local circumstances and the quality of the water to be treated.

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

(*Continued from page 5.*)

Near the summits or for short branches where sewers less than 2 feet in diameter are required, earthenware pipe is used, imbedded in concrete, as shown in Plate 7.

Main sewers are generally built in the middle of the street, but branch sewers on one side, about 5 feet out from the curb, as shown in Plate 8. The minimum depth, to bottom (inside) of new branch sewers is about 11 feet, but old ones are frequently 2 or 3 feet less.

Owing to the bad condition of the old sewers they are not ventilated at all (except undesignedly through the houses). But in new systems open ventilating manhole covers are being used. The form of these is shown in Plate 9.

House Drainage.

The house drainage of the old part of the city is even more abominably bad than the public sewerage—due in part to the defective condition of the latter, but more dependent on the prevailing indisposition of the inhabitants to any change from the habits of their forefathers, who, when sewers were not provided, naturally enough sought to get their sewage out of sight by putting it in deep holes in the ground, which is generally gravelly below a few feet of clay, and therefore for a time would drain off the liquids. So houses on streets where sewers had not been built were drained into leaching cesspools and afterwards when they became full and a sewer was accessible, overflows were run to the sewer from a large proportion of them. In his exhaustive report on a system of sewerage and house drainage for Philadelphia, made by Rudolph Hering in 1881, that engineer, after most searching inquiry, estimates the number of such leaching cesspools having overflows to the sewers at 25,000, or one-third of the whole estimated number at that date. This may now be somewhat in excess, but extensive inquiry among those best acquainted with the subject, proves that certainly many thousands remain, though a few each year have been filled up and their places supplied by "water-privies"—a small shallow vault of brick with cemented bottom, in which is an outlet to the sewer; they receive roof water and excreta from out-privies placed over them. The new house drainage regulations, however, forbid the further construction of the water-privy.

It has never been legal to connect cesspools with the public sewers, but it has been done chiefly (according to the Survey Department,) by obtaining permits for water-privies before there was any inspection. The law has also been evaded by running a pipe from the sewer up against the wall of the leaching cesspool. This succeeds in removing the liquid which the ground does not absorb, for a longer or shorter time, until the mouth of the pipe becomes stopped. Then the owner gets the cesspool excavator to pump it out and perhaps remove a brick or two at the mouth of the drain to the sewer that he may not again be at the expense of having it emptied. The preceding remarks on cesspools apply chiefly to the old part of the city previous to inspection. The Chief Engineer and Surveyor thinks that the practice above described is now impossible—though others in a position to know have different opinions.

From most of the cheaper class of old houses, and also many new ones in the rural portions, the waste water is run into the street gutter, generally over the sidewalk in a shallow depression*, and the fæcal matter dropped into a shallow leaching vault. These privy wells, estimated to number 5,000, as also the cesspools, are emptied by odorless excavators of which there are twenty-six companies licensed by the Board of Health. What is known as the Baltimore apparatus is used exclusively. The material is generally taken to some out-of-the-way-place in the city and placed in large pits, each layer being covered with lime as soon as deposited. Thence farmers remove a portion for fertilizer and some is treated with chemicals for conversion into artificial manure. The law requires that it shall be placed at least 200 yards from any house or road, but the Health Officer admits that with only two inspectors to watch twenty-six companies, probably much is dumped in less desirable places. So far as known none is dumped into the rivers.

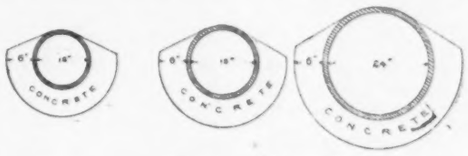


Plate 7.—Pipe Sewers.

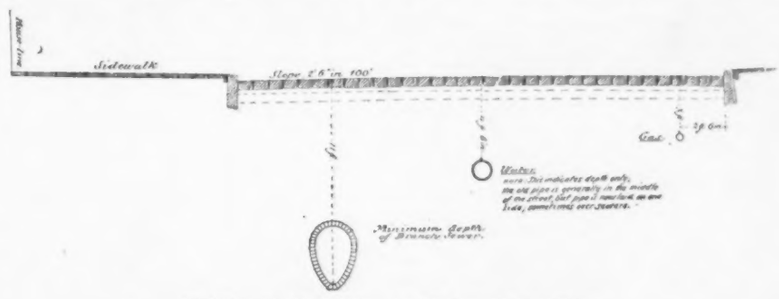


Plate 8.—Position of Sewers, Water and Gas Pipe.

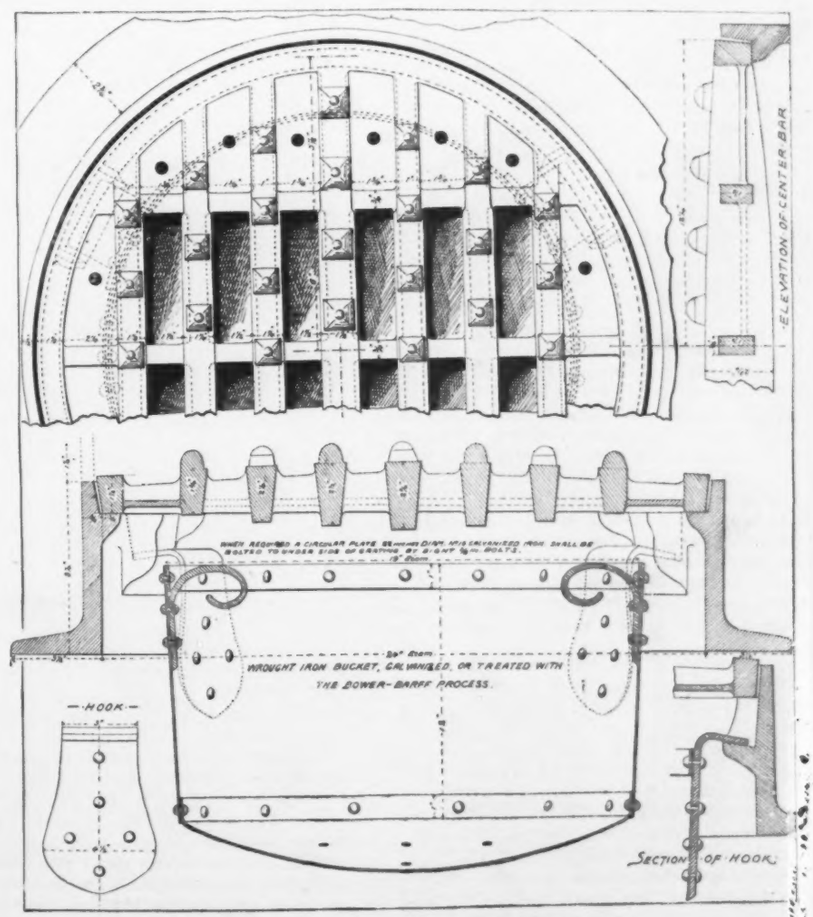


Plate 9.—Man-hole Cover and Catch-bucket.

*Copyrighted by the Engineering News Publishing Co., 1886.

*This practice is not allowed on streets having sewers, and on ninety days notice connections must be made with the sewers.

For more complete information on the sub-

jects of sewerage and house drainage, the reader is referred to the above mentioned report of W. H. Baldwin, C. E., made to Col. George E. Waring, Jr., Special Agent and Expert of the Census Bureau. Two inspectors of drain connections,are paid $1,200 each. (provided they do not engage in any other business during the business hours of the day). [Sewer inspectors are paid out of the separate appropriation for sewers—not more than $100 a month, for each].

Street System.

The streets of Philadelphia are notably regular, little attention having been paid to the natural topography. The rectangular system on which the old city was laid out has been adhered to throughout, and also the direction first adopted, except in the outlying districts where the original direction in the formerly independent villages has been retained—generally at angles of about 45 degrees with the main system. The numbered streets, (averaging about one twelfth of a mile apart) run approximately 13 degrees east of north, or nearly parallel with the Delaware river opposite the old city, and those bearing a miscellaneous variety of other names at right angles to them. The principal streets of the latter direction average about one tenth of a mile apart, frequently with one or two narrower streets between.

The street numbering is on the centennial system—starting a new hundred at every "square" or principal street. Buildings on the numbered streets (First, Second, Third, etc.,) are numbered north and south of Market, the principal business street running east and west (nearly), through the heart of the city. The odd numbers are on the north side of the named streets on the east side of numbered streets, example: 206 north Third street indicates the fourth door north of the second principal street north of Market, on the east side of the third principal street west of the Delaware river.

An exception in the name of the numbered streets is Broad (the principal north and south street which takes the place of Fourteenth street. There are a few diagonal streets on the lines of old roads running out into the country.

Width of Streets.

The streets range from 30 to 120 feet in width (between house lines), but most of the principal streets are 50, 60 or 80 feet, with 12,13, and 15 feet sidewalks respectively. Market, the principal east and west street, is 100 feet wide, and Broad, the principal north and south street, 113 feet. Since 1855 it is been illegal to accept for public use any street less than 30 feet in width, but in the old city many narrower streets remain, although property owners are required in making alterations on streets less than 20 feet in width to recede to a line 15 feet from the center.

Laying Out and Opening Streets.

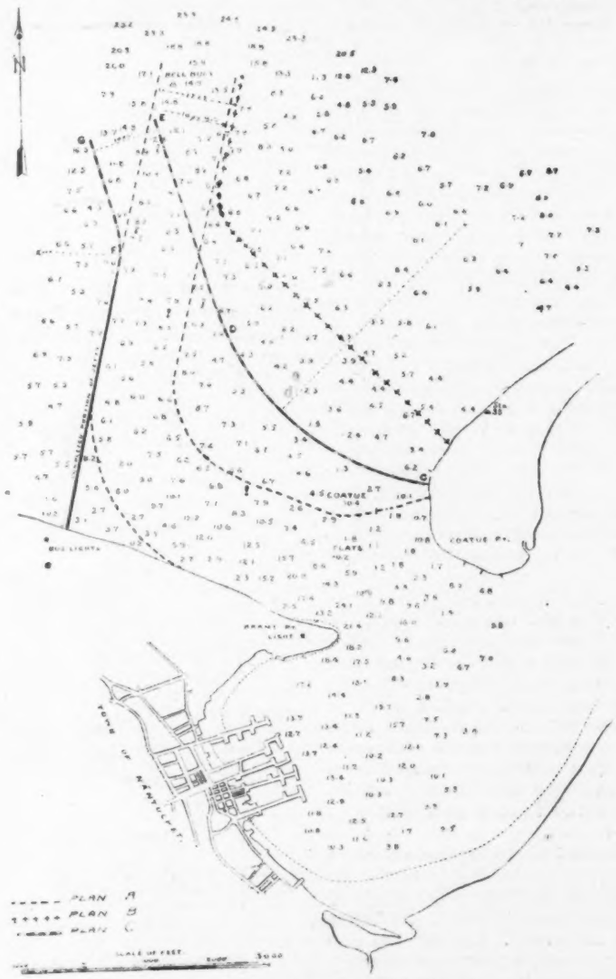
Streets having been placed on the confirmed plan of the city, may be opened in either of two ways: First, the property owners may petition the "court of sessions" for a "jury of view" to report upon the necessities of the opening, and if they report favorably the court usually appoints the same jury to assess damages. Secondly, Councils may by ordinance direct the Chief Commissioner of Highways to notify the property owners that the street will be required for public use within ninety days, in which interval the owners apply to the court for a jury to assess damages. Highways in use twenty-one years or more also become public streets.

TO BE CONTINUED.

The Proposed Harbor of Refuge at Nantucket, Mass.

Nantucket harbor, on the north side of the island of Nantucket, has deep water inside and would form an excellent harbor of refuge for vessels where it not for the shoal bar which obstructs its entrance. Only one other harbor, the small one at Hyannis, lies between the harbors of Martha's Vineyard and Provincetown, a distance of 100 miles. It is stated that 30,000 vessels annually pass through this thoroughfare with its intricate navigation and numerous and perilous shoals.

The map given herewith and the following data concerning this work are taken from the last report of Lieut. Col. George H. Elliot, U. S. Engineers. Before the commencement of the present works there was a shoal 1¼ miles wide outside the entrance, with a very crooked channel through it and about 6 feet of water at mean low tide; the mean rise and fall of tide being about 3 feet.



Plan of Nantucket Harbor.

The present approved plan is to construct jetties of riprap stone projecting from either side of the present harbor-entrance, so arranged as to concentrate the strength of the tidal current and excavate a deep channel by scour. At the close of the fiscal year, ending June 30, 1884, $88,181.11 had been expended in constructing the western jetty (see plan) to a point 3,515 feet from the shore initial point. The work of the fiscal year ending June 30, 1885, extended this jetty about 440 feet.

The cut shows alternative plans, suggested in part by the experience gained, for the location of the eastern jetty. Plan *A* is the proposed location of the jetties in case the channel is to be excavated by tidal scour throughout; Plan *B* is a location for part tidal scour and part dredging. The Board of Engineers in its report of July 17, 1885, stated that it adopted the latter of these plans but proposed some modifications which are shown in Plan *C*. The chief advantage of either Plans *B* or *C* is that the harbor can be enlarged by dredging in the outer harbor, if, in the future, the present harbor should be found too small for the number of vessels seeking refuge at Nantucket. The amount required to complete the existing project, Plan *C*, is estimated at $265,000.

The original plan proposed jetties of rip-rap granite, extending 5 feet above mean low water and triangular in section out to 4,000 feet from shore for the western jetty; the remainder of this jetty was to be 4 feet wide at top, with an enlarged section at the outer end. Both jetties were to have side slopes of 1 to 1. To August, 1884, this west jetty had been carried out 3,955 from shore; the first few hundred feet settled in the sand somewhat but when re-levelled remained in good condition, and the general result showed that the stone soon settled to a permanent bed and that mattresses were not needed here. Very little deepening effect has been observed due to the construction of the one jetty. Borings show that the material underlying the work is mostly very compact sand, covered in many places with sea-weed and mixed with varying proportions of gravel. This gravel is expected

to remain as a pavement when erosion to a certain depth has taken place and the sand of the remaining bed is sorted out by the current and it may then require dredging to obtain the desired ultimate depth.

The single jetty having failed to make any impression on the depth of water, another jetty is required and in recommending its location and height, Col. Elliot submitted the following general considerations:—

"Whatever width of jetty channel may be decided on, there will be a portion of time during each ebb and each flood when the bottom velocities will not be sufficient to move the material of the bed and of the bar, and prevent deposits. During the remainder of each tide (unless the width of channel be excessive) this material and these deposits will be in motion, outward on the ebb, inward on the flood. If the outward and inward movements of the material should be equal, not only would there be no deepening of the channel, but it might become shoaler than it now is, by means of new deposits. If they should be unequal the channel would be deepened provided the resultant of the movements should be outward, but the harbor might be shoaled if the resultant should be inward. The times of ebb and flow at Nantucket being essentially equal, and unlike the mouth of the Mississippi and all the harbors on the Atlantic and Gulf coasts, at which the jetty system has been applied, there being no outflow of fresh water to strengthen the ebb, the mean velocity through the jetty channel during the entire flood will generally be the same as during the entire ebb, whatever the width of jetty channel.

The success of the application of the jetty system at Nantucket would seem, therefore, to be doubtful, but it is universally conceded that the scouring effect of the ebb is superior to that of the flood tide (although the cause of it is only surmised), and even in such an unpromising case as Nantucket may appear to be, the resultant of the outward or forward movement of the material of the bed of the channel during the ebb, and the inward or backward movement during the flood (whether by reason of the inclination of the bed or the carrying in of water by on-shore wind-waves of translation, or otherwise) may be assumed to be outward. Although it will require more force to erode the contracted bed of the proposed channel than to maintain it afterward, the velocities before and during erosion will be greater than when the channel will have been established. I therefore assume that if the velocity required to maintain the desired channel be properly determined, the antecedent higher velocities will excavate the channel.

Necessity for High Velocities.—Dubuat observed that sand dragged by currents down the beds of streams moves in the form of waves, and in the case of a stream flowing with a bottom velocity of from sixty-seven hundredths to 1 foot per second, he found that the sand moved at the rate of about three miles in two years, or about 21¼ feet per day. The observations of General Comstock on the Mississippi river (Report of the Chief of Engineers, 1879, Vol. III. p. 1892), and of the late General Warren on the Wisconsin and Mississippi rivers (Report of the Chief of Engineers, 1876, Vol. II. p. 258), appear to confirm Dubuat's statement, as do also the reports of the Mississippi River Commission. General Comstock reported the rate of motion of the sand waves (which is equal to the average rate of motion of the grains of sand which form the wave) at about 18 feet a day. General Warren estimated the rate of motion of the sand waves observed by him, to be about 800 feet a year. In one case of observation under the Mississippi River Commission, the mean velocity of the water being 3.5 feet per second, and the depth from 20 feet to 30 feet, the average daily motion of the sand was 13 feet, and the maximum daily motion was 20 feet. At another place where the mean velocity was 5.8 feet per second, and the depth of water from 45 to 60 feet, the average daily motion of the sand was 35 feet. The length of that part of the jetty channel at Nantucket which requires to be excavated is about 8 000 feet, and at the rates just noted, it would be more than a year before the sand at the upper end of this space would begin to reach the outer side of the bar. This is under the supposition that the sand would be always moving in the same direction, as in the case of a non-tidal stream. But our case is different. In the first place, during the times of slack water, and for some time before and after slack water, there will be no motion of the material of the bottom; and in the second place, the outward resultant of the inward and outward movements of this material during the remainder of the time (that is, during the time when the bottom velocities will be effective as regards scour), will be but a small fraction of the movement that would obtain were the current always running in the same direction. In other words, instead of motion always outward, each successive thin layer of sand on the surface of the bottom of the jetty channel will be at rest a considerable portion of the time, and during the remainder each flood will carry it nearly as far backward as the preceding ebb has carried it forward, and the motions of the sand will be similar to those of sewage held in suspension, which in the Clyde and Thames were found to have a resultant motion towards the sea of about five miles in a fortnight. I should suppose, however, that the difference between the alternate motions of sand on an inclined bed of a tidal stream, the velocity of the current being the same, would be greater than those of sewage in suspension. It is for these reasons, it appears to me, that the deepening of the entrance to all tidal harbors by means of jetties is a very slow process, and especially must this be the case when, as at the entrance to Nantucket harbor, the ebb and flow, both in respect of time and of the quantity of water in motion, are essentially equal; and if this view be correct, it is not strange that in all our jetty channels erosion has been so tedious, and resort is often had to dredging. Even at the South Pass of the Mississippi, with outgoing velocities of 3, 4, 5 and 6 feet per second the scour of the sand on the crest of the bar was exceedingly slow, and at Dublin harbor, a case of successful application of the jetty system (and very much like ours at Nantucket), where the surface velocities at spring tides are three miles per hour (or more than 4 feet per second), the scour which has deepened the water on the bar from 6½ to 16 or 17 feet at low water, has had only an average yearly rate of about 1¾ inches.

It seems to me, therefore, of very great importance since the outward resultant, or the difference between the inward and outward movements of the material of the bed of the channel will be the greater, the greater the velocity of the water, that we provide for as high a velocity as the conditions governing the case will allow.

Effective Bottom Velocities.—I assume that to scour such material as composes the bed of the proposed channel and of the bar, sea-sand mixed with gravel, there is required a velocity of the water in the channel close to the bed (the bottom velocity) of at least 1.25 feet per second. The authorities differ in respect of the velocity required in a case like the present, as will be seen from the following statements, in which the velocities are in feet per second, and, unless otherwise stated, bottom velocities.

Dubuat is variously quoted by different authors, but in his table of experiments he gives the following velocities as required to move various substances: Sand of the size of anise seed, .5; coarse yellow sand, 1; Seine gravel of the size of peas and little beans, .67 and 1.46, respectively; rounded pebbles, 1 inch in diameter, 3; and angular gravel, the size of hens' eggs, 3.75.

Mr. Login (quoted by David Stevenson) gives for sand as coarse as linseed, .67; fine gravel, 1; and rounded pebbles 1 in. in diameter, 2.

Weisbach says that in canals a mean velocity of 1.25 is required to prevent sandy deposits, and that in case of a sandy bottom the mean velocity should not exceed 1.

Debuat states that sand is moved with a velocity of 1.

Other authors, instead of stating the bottom velocities required to "lift," "just lift," and "move" various substances on the beds of streams and canals, give what are termed "safe velocities," that is, velocities of the water under which different materials are not moved and the bed remains stable. In the hydraulic tables of Kutter we find that a sandy bottom is stable under a velocity of 1; that a gravelly bottom is stable under a velocity of 2, and that pebbles are not moved with a velocity of 3.

Des Ingenieurs Taschenbuch (Hütte) states that 1 is a safe velocity for a sandy bottom and 2 for a gravelly bottom.

Morin gives 1 as a safe velocity in case of sand.

Mr. Login, after much experience in the construction of canals in India, states that deposits take place with velocities far in excess of those which we find in Dubuat's work.

At Oakland harbor, California, Colonel Mendell at my request measured the velocity of the ebb in the deepest part of the channel between the jetties, where there were reported to be deposits of sand which the current failed to remove. The tide was about one-half ebb, and the depth of water was about 14 feet at mean low water. The surface velocity was 3.64 feet per second, and the mean velocity as, found by a pole loaded so as to take an upright position, was 2.92 feet. The bottom velocity was therefore about 2.20 feet per second. The sand, of which he sent me a sample is very fine. It should be remarked in this case that the sand in the Oakland channel is washed from the banks by the swash of passing steamers. It may be, therefore, that the daily supply is greater than the current can fairly be expected to remove.

At Nantucket, on a line parallel to and about 150 feet east of the western jetty, the ebb surface velocities from 1,000 to 3,200 feet out from shore are now from 1.33 to more than 2 feet per second and yet no appreciable wear of the bottom, takes place. I therefore assume that the bottom velocity required to scour the material at Nantucket is, at least, 1.25 feet per second, and in the calculations to be made for the width of the jetty channel I shall adopt this for the mean of the bottom velocities in the channel during each entire average ebb, under the supposition that the bottom velocities will be equal to and exceed this velocity during about two-thirds of the ebb, and that no scour is to be expected during the remainder of the ebb.

Maximum Velocity of the Current in Midchannel.—Let 1.25 feet per second be the mean bottom velocity of the water passing through any section of the jetty channel during an entire tide, then $1.25 \div .75 = 1.66\frac{2}{3}$ feet per second and $1.66\frac{2}{3} \times 1.57 = 2.62$ feet per second, will be approximately the corresponding mean and maximum velocities of the whole section during an entire tide, respectively, and, denoting by x the greatest surface velocity in the middle of the channel at the time of this maximum velocity of the whole section, we have by Prony's formula:

$$\frac{2.62}{x} = \frac{x + 7.71}{x + 10.28}$$

or $x = 3.2$ feet per second (about). This is at the rate of about two miles per hour, and it is not likely to prove at all inconvenient to navigation.

Alternative Locations.—It is evident that in order to produce a deep channel by tidal forces alone the contraction of the water-way from one end to the other—that is, from the pocket of deep water before referred to, to the outside of the bar or shoal—must be such as to produce a scouring velocity throughout the entire length of the channel.

Assuming for the desired navigable depth of channel the same as the depth of the deeper part of the harbor inside, 15 feet at mean low water, the low-water mean depth of the channe will be about $15 \times \frac{3}{4}$, or $11\frac{1}{4}$ feet, and the half-tide mean depth $12\frac{3}{4}$ feet. The average contents of the tidal prism above the mouth of the harbor is 529,050,157 cubic feet, and assuming that one-tenth, or 52,905,015 cubic feet, will be lost by leakage through the jetties, there would remain 476,145,142 cubic feet as the effective contents (effective for scour) of the tidal prism.*

The mean duration of the ebb-tide is five hours and forty-four minutes, or 20,640 seconds. As before stated, the mean velocity of the tidal current through any cross-section of the jetty channel during an average tide is to be $1\frac{5}{8}$ feet per second. Representing by Vm this mean velocity in feet per second, Q the contents of the effective tidal prism in cubic feet, t the duration of the average tide in seconds, d the depth, and W the width of the jetty channel in feet, we have

$$W = \frac{Q}{t \times Vm \times d}$$

and substituting the above values we have

$$W = \frac{476,145,142}{20,640 \times 1\frac{5}{8} \times 12\frac{3}{4}} = 1,085 \text{ feet at one-half tide,}$$

corresponding to a width of 1,092 feet between interior crests of the jetties, in case the entire channel from the pocket of deep water outside the present mouth of the harbor to the outside of the bar is to be excavated by tidal scour alone. The eastern jetty in this case, I would propose to start from the southernmost of the three short spurs which are on the extreme western point of Coatue, and carry it thence on a line running southwesterly until it would intersect a line parallel to and about 1,500 feet from the beach west of Brant Point; thence along this line and a tangent curve drawn with a radius of 1,500 feet connecting this portion of the jetty with the main portion, which would be parallel to and 1,092 feet from the western jetty. This position of the jetty and the corresponding position of the channel are shown on the accompanying drawing, marked A, which also shows the position of a half tide training-wall, by means of which, the eastern jetty being in this position, I would propose to regulate the channel in the angle between the western jetty and the shore east of the western jetty.

The alternative and in my judgment the better location of the eastern jetty which I propose for adoption, is shown on the accompanying drawing marked *B*. The entire tidal prism is this case contains 592,150,627 cubic feet or 63,100,500 cubic feet more than the other, and it is considered that this increase of tidal prism is of especial importance, in view of the anticipated loss of water through the jetties, which loss would have to be borne by the tidal prism above the mouth of the harbor alone, in case the jetty should be built on the inner location. Allowing 10 per cent. loss by leakage, as before, we have for the effective contents of the tidal

*In regard to the allowance for loss of water by leakage through the jetties, it will have been observed in the description of the western jetty that the width of its inner portion at the mean low-water line is only 10 feet, and of its outer portion only 14 feet. On account of the size of the riprap stones it is found difficult to build with a less width at top than 4 feet, and I propose that the eastern jetty shall have a width at the low-water line of 14 feet throughout. The widths of the jetties being so small and the interstices large, a large amount of water will pass through them, and there will be a corresponding loss of head of the water inside, which will reduce the velocities of the currents through the mouth of the jetty channel. At the mouth of the Mississippi it was estimated that from 30 to 40 per cent. of the water passing through South Pass was lost by leakage through and over the jetties.

prism above the outer location of the jetty 532,935,592 cubic feet, and assuming the same formula and the other quantities as before, we have.

$$W = \frac{532,935,592}{20,640 \times 1\frac{5}{8} \times 12\frac{3}{4}} = 1,215 \text{ feet at half-tide,}$$

corresponding to a width of 1,222 feet between the interor crests of the jetties. The eastern jetty in this case I propose to start at a point on the beach off Coatue, about 750 feet southwesterly from Triangulation Station No. 35, and to carry it thence in a northwesterly direction on a line which, if prolonged, would intersect the line of the western jetty about 5,780 feet from its extreme inner end, and on a tangent curve drawn with a radius of 1,000 feet, connecting this portion of the jetty with the portion which will be parallel to the western jetty, and 1,222 feet from it. I give the parallel portions of the jetties a length of 1,500 feet in order to provide that the ebb shall issue square out from the mouth of the jetty channel, and not obliquely. In case the eastern jetty is built on the outer location, resort must be had to dredging between the deep water at the mouth of the harbor and the inner end of that part of the length of the channel which will be excavated by scour. This point will probably be not far inside the inner ends of the parallel parts of the jetties. It is proposed to make the width of the dredged channel in the first instance 300 feet, and the depth 12 feet at mean low water, and to increase the width and depth as necessity requires.

Height of the Eastern Jetty.—I submit the following considerations concerning the height of the eastern jetty:

(1) If the inner part of the jetty be built only to a low level, say to half-tide, it is almost certain that in a very short time, probably within a few months, the sand would bank up on the outside to the top, and would then commence to be carried over the jetty at half-tide of every flood. This sand would soon encroach upon the channel and crowd it over toward the shore at and to the westward of Brant Point, as is now the case, and it would be likely to form shoals in the channel farther down, making it tortuous and difficult of navigation. It is proper here to note the fact that, standing after a storm on the end of one of the short spurs which run out from Coatue, the water there being 3 or 4 feet deep and otherwise clear, and not agitated by waves at that place, I have seen it literally "alive" with sand nearly to the surface during the higher velocities of the flood, which are there about 3 feet per second.

(2) Outgoing currents neither containing nor dragging along solid matter from above would have much greater scouring power, and would be much better able to keep down the bar at the mouth of the jetties which the waves will tend to re-form during every on-shore wind than if the water should arrive at the bar already loaded, perhaps to saturation, with sand carried in over the low part of the jetty. In other words, it is desirable to retain the full working power of the ebbing current in respect of scour rather than to incur the risk of giving it an unnecessary duty.

(3) It appears to me that another objection to any part of the jetty being low would be the resulting comparatively short duration of the higher velocities of the ebb which are required to produce scour. If the ebb tide should run freely over the low part of the jetty until half ebb, the duration of ebbing scour in the channel and on the bar, which at the best would be only a part of the ebb, would be reduced about one-half.

(4) Another objection, but one which could be obviated by an increased expenditure, would be the lifting and dragging from their places of the riprap stones forming the upper part of the jetty, by ice. During a part of every winter large fields of ice drift across Nantucket sound from the north shore and blockade the harbor, sometimes to such a degree that the mail steamer cannot get in or out for weeks. Should the ice be run over the top of the jetty by the tides, instead of being stopped by the jetty, which latter would be the case with a jetty rising above high water, the upper portion of the jetty, in order to prevent its being degraded every winter, would have to be constructed in a compact manner with very heavy stones.

(5) If we have a width of channel between the jetties that I propose, and we obtain the anticipated depth, I think there will be no danger that the rise and fall of the tide in the tidal basin within the harbor entrance will not be as great as is now produced by the wide but shallow stream which crosses the outside flats. For the foregoing reasons I am of the opinion that the eastern jetty should be built throughout to the height of the western jetty, that is to 5 feet above mean low water, or 2 feet above mean high water.

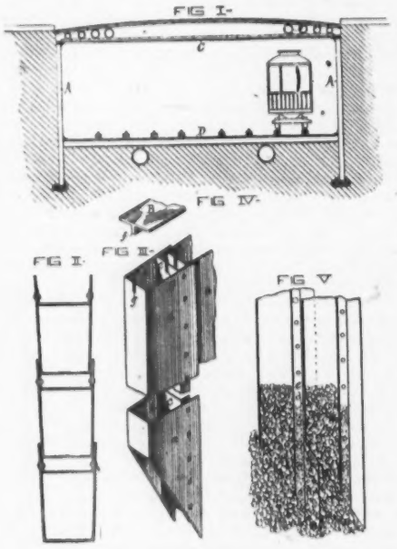
THE difficulty of sighting rifles in the dark in warfare has been ingeniously overcome by the use of luminous paint. A small luminous boat is clipped on to the rifle over the fore sight and another over the rear sight when used at night in reply to an enemy's fire forming two luminous sights. The English War Office authorities have had some of these sights under trial for the past six months, and have now given their first order for some.

Water-tight Bulkheads for Subways, Etc.

The accompanying illustration shows a proposed system of water-tight bulkhead for various purposes, patented by Mr, John E. Robinson, of Baltimore, Md., on December 14, 1886.

The purpose of this invention is the formation of a water-tight and strong sheet-piling, or bulkhead, on each side of the proposed excavation and to complete this wall before material is removed from within or any thrust can come from earth outside. The slipping of earth into the cut and the consequent danger to neighboring buildings is to be prevented.

The piles used are made by bending a sheet of metal, of any desired length, into a U-shape with a slightly widening mouth and with dimensions of 8x15 inches; into the mouth is then riveted another U-section of iron, 8x3-inches, completing the tubular pile as shown in Fig. 2. These piles have a wedge-



Subway Bulkheads.

point and are to be thoroughly coated by a similar compound preservative to that used on cast-iron water-pipe.

The method of practically applying this system, say for the construction of a subway in wet or treacherous ground, would be as follows:—The workmen would first dig a ditch 4x4 feet along the proposed line of piling; a small movable pile-driver and a pump and water-tank to supply a water jet, where pressure from water-mains would be insufficient, would about complete the outfit. The piles would then be placed and driven so that the back of one would fit into the mouth of the other as shown in Figs. 2 and 3; the water-jet would be employed to wash out the sand or earth and to widen out the bottom cavity if desired. When in place these interlocked hollow piles would be filled with concrete and the space shown between the adjacent piles well grouted with Portland cement.

The heads of the piles would be driven level with the bottom of the 4-foot trench and then capped with the wrought-iron flanged plate Fig. 4. The foot of the pile would extend a sufficient depth below the proposed excavation to insure stability; and all pipe-connection between the street and houses would pass over the wall. With the piles in position and capped, on both sides of the proposed excavation, trenches are dug from side to side 4 feet deep and the roof-girders, shown in Fig. 1, are put in place and secured to the cap *B*, or by brackets to the piles. The heads of the piles being thus braced the material between is then removed to the required depth and a lower floor-girder may be put in as shown. The roof-girder must be proportioned to the span of the street and traffic above and they are spaced in accordance with the same; longitudinal beams and steel buckle-plates complete the roof ready for any road formation desired. The sewers would be sunk below the floor, and the inventor suggests that electric wires, pneumatic tubes, gas and the lighter water pipes may be carried through stiffened openings in the girders.

While it is claimed that this system is sufficiently strong in its walls to answer for many purposes with the filled piles alone, it is a comparatively easy matter to reinforce them with masonry inside if greater strength is required. It certainly has inherent advantages, especially in safety from the slipping which would endanger adjoining structures, and a double line of piles would provide a very substantial wall. One of the difficulties to be overcome in a city like New York, would be the obstruction to the driving of the piles likely to be met with in buried pipes, old foundations and from the masonry of vault-walls projecting beyond the curb-line. These are conditions, however, that would interfere to some extent with any method of securing a foundation. The chief claim is for a cheap and durable wall and one safe for excavators and adjoining property, and this claim the inventor believes he has made good.

Fuel Bricks From Coal Dust.

Briquettes, or fuel bricks from coal dust, are growing in favor and demand in Europe. Scotland has at last fallen into the ranks of briquette-making nations.

One of the largest coal-mining and pig iron, making firms thare are now erecting a plant with a capacity of 200 tons a day.

In France and other continental nations the business is large and growing.

Jules Chagotolia, of France, and Carlo Raggio, of Italy, have each increased their plants by one new one annually for the last six years, till now they have a yearly capacity of nearly 350,000 tons each. Other firms have also gone into the buisness largely.

The business is likely to get a start in this country soon.

Pittsburg parties analyzed a French briquette lately, and found it a fuel of rare purity and power. There, where coal dust costs nothing, the profits of briquette-making for locomotives and shipment would be large.

THE PROGRESS OF THE ART OF TUNNELING. — A French writer directs attention to the constant progress made of late years in tunneling and drifting through rock. Along with improvements in rock drills have come no less marked improvements in explosives. The results have shown themselves in a constant increase in the rate of advance. Thus, in the Mont-Cenis tunnel the average rate was 1.75 meters a day. In the St. Gothard tunnel, where more powerful explosives were used, the rate was 2.75 meters. In the Arlberg tunnel further improvements in the drills and explosives used, with a better organization of the work, raised the rate of daily advance to 4.15 meters. More recently the Levant tunnel was driven at a rate of 4.50 meters a day. And the last great work of this character, the Carrito tunnel in Italy, where blasting gelatine was used in deeper holes than dynamite could work in effectually, shows an average daily advance of 5.40 meters. Some allowance must, of course, be made in these estimates for difference of rock and other conditions of the problem; but as these averages are for the whole work, they represent approximately the progress made in the science and practice of mining since the completion of the Mont-Cenis tunnel.

The Asphaltum Deposits of California.

The existence of deposits of asphaltum on the Pacific coast of our own country is a fact not generally known, therefore the following abstract is made from the official report of E. W. Hilgard, published in the "Mineral Resources of the United States," 1885:

The petroleum-bearing formation of California embraces the main body of the Coast range around and south of San Francisco bay to, at least Anaheim, Los Angeles Co. Indications of bitumen are found as far north as Cape Mendocino. As the latitude of Santa Barbara county is reached the petroleum-bearing strata are found above the ordinary country level, and the oozing out and partial evaporation of the oil gives rise to easily accessible deposits of asphaltum; this mineral also occurs under other conditions pointing to distillation by subterranean heat as the chief factor in the solidifying process.

The important asphalt deposits of California lie within the counties of Santa Barbara, Ventura and Los Angeles the first and the last furnishing the present commercial supply.

It is in Ventura county, however, that the oil-bearing formation can be best studied. There seems to be here at least two petroleum-bearing levels, a thousand feet or more apart; with the lower throughout more prolific of oil while the upper is the source of innumerable local outflows of a usually thick, blackish-green oil that hardens gradually into solid asphaltum on exposure to the hot sun of this region.

In the Santa Paula valley the bounding ranges are of the usual sand-rock with intercalated ledges of a cavernous calcareous sandstone; on the northern slope of these ranges an outflow takes place which both in kind and apparent quantity is unusual and impressive. The thick oil or pitch oozes out at a level several hundred feet above the valley, in the heads of ravines, and forms surface deposits which appear as walls or terraces along the slopes, or move more commonly in glacier like masses down the ravines and partly solidify into rock-like masses on the hill sides. In the valley below it sometimes accumulates in masses several acres in extent and at points 15 feet thick. These masses however are far from being pure asphaltum, as in their descent they have picked up every moveable object from boulders and tree-trunks to twigs and the bones of animals caught in the once viscid mass. Mr. Hilgard says, however that the popular estimate of the existing volume of this material is much exaggerated by the occurrence of large surfaces covered with only a thin sheet of the pitch. Within eight miles of San Buenaventura landing he estimates that there are about ten acres of ground covered from 2 to 3 feet deep with the crude mass. But nearly every ravine up the lower Ojai valley for eight miles affords a larger or smaller deposit of similar material, representing a very large aggregate.

At a point sixteen miles from the seashore there is a somewhat sudden ascent of 500 feet from the lower to the upper Ojai valley, and here the level is reached from which the tar flows. Terraces of asphalte appear on every hand, at one place a bubbling caldron of tar and water supplies a flowing stream of liquid matter that creeps lazily along for a distance of about 600 yards. From the semi fluid tar to the hard but somewhat cellular asphalte every shade of transition is found in this valley; here six acres of ground would seem to be covered with the deposits to depth of 2 and perhaps 4 feet.

From the eastern end of these deposits the drainage is towards the Santa Paula valley; and here, flanking the valley of Seesaw creek, is the largest of the deposits of this region. For half-a-mile the southern mountain side bears huge terraces of asphalt from which ooze constant streams of black oil and tar. Mr. Hilgard estimates this deposit at 100,000 tons and that within the three miles between this place and the ascent from the lower Ojai valley the aggregate must reach at least 1,000,000 tons. The country rock is a brittle clay shale, with the fragments intermingled with the asphaltum; but he says that abundance of the pure material could be collected.

The retort assay of representative samples gave the following results:

	No. 1. Upper Ojai.	No. 2. Seesaw Cañon
	Per cent.	Per cent.
Volatile matter.	35.8	39.0
Carbon.	28.2	21.0
Ash (gravel, debris, etc.)	36.0	40.0
	100.0	100.0

In Los Angeles county, the most noted asphaltum deposit, and the one mainly worked, is on the Rancho de la Brea, seven miles west of Los Angeles, nine miles from Santa Monica landing and only two-and-a-half miles from the Monica branch of the Southern Pacific R. R. Outcrops of asphaltum here occur over eighty acres, with numerous springs of tar, water and gas; around each of these springs is a mushroom-like mass of asphalte often yielding tons of the purest mass. Besides these there are three large bodies of asphalt, evidently filling deep basins and once forming tar-lakes; the mineral here softens as the depth increases and is often mixed with the soft, shaly sand-stone of the country and an extraordinary mass of animal bones. At other points an asphaltic sandstone occurs of rough and gritty fracture.

When Mr. Hilgard visited these mines only the largest of the three pits was being worked, and the excavation represented a volume extracted equal to 100 by 300 feet in surface and 30 feet in maximum depth; in no place had the lower limit of the deposit been reached. The working was crude and disorganized, but the foreman estimated that about 50 per cent. of the crude material mined was obtained in the shape of "refined" mass. The quarried asphalte is melted in cast-iron pans, 8 feet by 3 feet, the lighter gravel, small bones, etc., are skimmed off and the liquid matter poured out into rough moulds forming bricks weighing from fifty pounds upward. As far as can be ascertained about 15,000 tons of such "refined" asphalte had been taken from the mine at the time of Mr. Hilgard's visit. The surface area is about eight acres, with an as yet unknown depth. There are other near deposits aggregating in all about fifteen acres, with a minimum depth of 30 feet of asphaltic materials Assays gives the following results for various samples:—

	No. 3. Purest Natural.	No. 4. Rock.	No. 5. Hard Surface.	No. 6. "Refined."
	Per cent.	Per cent.	Per cent.	Per cent.
Volatile matter	71.4	29.6	40.1	41.5
Carbon.	14.4	18.4	23.0	16.9
Ash.	14.2	52.0	36.9	41.6
	100.0	100.0	100.0	100.0

In Santa Barbara county bituminous deposits are wide-spread. At the Rancho de las Galetas is a black mass of asphaltum, more or less mixed with sand, which forms what appears to be a regular fissure vein or dyke with a mass 30 feet in average thickness; it runs out into the sea as a rocky ledge, and at low tide the best material is quarried from the sea bottom; 160,000 tons of the material are estimated "in sight." Every indication points to the existence of a large deposit at this point. The assays give results as follows:—

	No. 8. Lower porti'n	No. 9. From pile.	No. 10. Purest.
	Per cent.	Per cent.	Per cent.
Volatile matter.	23.1	32.8	40.2
Carbon.	6.0	10.4	11.7
Ash (sand)	70.9	56.8	48.1
	100.0	100.0	100.0

This locality supplies most of the asphaltum used in San Francisco, and in 1878 1,500 tons were shipped at prices, delivered at the city, ranging from $15 to $20 per ton.

It might be added that this examination and report was originally made in 1878 by Mr. Hilgard for Mr. Henry Villard, but have only recently been made public. We understand from other sources that the asphaltic sand, probably from Santa Barbara, is used very successfully in a crude state in road formation about San Francisco. This asphaltic sand is very likely applied in a similar manner to the *asphalte comprimé* of the French; which is the native rock simply pulverized cold, then moderately heated and rolled in place.

STEADYING CHIMNEYS BY LOADING. — Herr A. Hollenburg contributes to the *Zietschrift* of the German Society of Engineers an article upon the prevention or diminution of oscillation in chimney-stacks and high walls by loading with an excess of dead weight. He cites an instance of a chimney only 56ft. high, built in common lime mortar, which when completed was observed to oscillate to an alarming degree. Consequently the chimney was loaded by putting on the top an iron plate weighing upwards of 2½cwt. The cure was perfect. Although the stack is built in an exposed situation, it has stood for 16 years, during which many severe storms have tried its strength, yet it does not show any horizontal or vertical cracks. Similar results are recorded in connection with the construction of a mill at Müllfort, near Rheydt. Here a millowner found it necessary to heighten a building by two stories, without interrupting work in the factory below. The constant vibration caused by the machinery, however, destroyed the walls as soon as the bricks were laid. To check this effect the walls were heavily loaded with iron rails as fast as the cement would bear them; and by this means the additional height was safely reached—the vibration of the walls being completely stopped. Heavy stone and iron curbs for chimneys are not so generally placed upon chimney tops as formerly. It is commonly thought that these finishing touches were intended for ornament only; but according to these foregoing statements, there may have been more reason for them than has been generally supposed.

T. F. RANDOLPH, manufacturer, importer and dealer in surveyors and engineers instruments, sends his latest catalogue, illustrated and priced. The plates show various special features of design, tending to either improve the efficiency of the instruments or reduce its price. Among these we note a Vernier Telescope Compass, compact, and accurate and selling at a small advance over the ordinary sight compass; telescope attachments to common compass and folding-plate compasses may also be noted. The railroad transits figured, and in fact all the instruments for ordinary work having telescopes, have the telescopes supported by only one standard, leaving a very clear compass or Vernier sight, and reducing the weight and cost. Send for circular to No. 51 Fourth St., Cincinnati, O.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XVII. Saturday, January 8, 1887

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

PHILADELPHIA OFFICE.
504 WALNUT ST.
W. M. PATTON, Manager.

Authorized representative for Pennsylvania, New Jersey and Delaware. Advertising rates made known on application.

TERMS OF SUBSCRIPTION.

TO U. S. AND CANADA.

One Year	$5.00
Six Months	2.50
Three Months	1.50
Single Copies	12 cts.

OTHER COUNTRIES.

Add Postage 3 cents for each number.

New Advertisements this Week.

ENGINEER. W. SCOTT WEST. New York.
INSTRUMENTS. T. F. RANDOLPH. Cincinnati, O.
CIVIL ENGINEER. POSITION WANTED. This Office.
SEWER PIPE. CALUMET FIRE CLAY CO., Calumet, O.
SUPERINTENDENT. WANTED. N. Y. City.
MINING ENGINEER. POSITION WANTED. This Office.
CAST-IRON PIPE. BOSTON WATER BOARD, Boston.
WATER WORKS. CONSTRUCTION. Junction City, Kan.
TAINTOR & HOLT. WATER WORKS BONDS. N. Y.

TABLE OF CONTENTS.

	PAGE
Civil Engineering Education	19
Municipal Engineering (*Illustrated*)	23
The Proposed Harbor of Refuge at Nantucket, Mass. (*Illustrated*)	24
Water Tight Bulkheads for Subways, Etc. (*Illustrated*)	25
Fuel Brick from Coal Dust	26
The Asphaltum Deposits of California	27
Editorial Notes	28
Heliography. A Correction.	28
A Combination of Bridge Builders	28
Snow and Salt in New York	28
The American Iron Trade of 1886	29
Sewer Assessments in Fall River, Mass.	29
Aqueduct Commission	30
Cast Iron or Steel Piles	30
Personals	30
American Society of Civil Engineers	31
The Illinois Society of Engineers and Surveyors	31
Association of County Surveyors and Civil Engineers of Indiana	31
Annual Meeting of Mining Engineers	31
Illinois Tile-Making Association	31
Connecticut Association of Civil Engineers and Surveyors	31
Correspondence	31
More Important Features of Large Reservoirs for Irrigation	31
Water	32
News of the Week	33
Market Report	36

THE Nicaragua Ship Canal bill has been reported upon favorably by the Committee on Foreign Relations. The bill names certain incorporators; provides for the issue of not more than $100,000,000 of capital stock; fixes tolls at a maximum of $2.50 per ton, and provides that the privileges granted shall expire unless one-tenth of the stock is subscribed within two years and work actually begun within four years.

A WICKED correspondent, who is evidently lacking in due respect for the science of surveying, suggests that we engage Mark Twain to contribute an article on the intricacy of adjustment of the Wye Level. The English Dumpy would perhaps make a more entertaining topic, with its reversal of the rodman and right and left motions. A new and untrodden field is certainly here presented for the American humorist.

The *Army and Navy Register* seems disturbed at Mr. Dorsey's proposal that low carbon steel would be better for guns and writes of paid advocates and subzidized advocates of the Pittsburg soft steel makers.

When the papers of the country noted the anomaly of an officer of the United States Navy acting as a drummer for Schneider & Co. it was to be expected that Lieut. Commander Barber and his friends should say that the objections to his course originated through the promptings of proposing bidders who thought they had been delayed in procuring information at the Navy Department. But we do not see why a man with a soft steel bee in his bonnet should be thought to be paid or subsidized by Pittsburgers, or that the fact that soft steel is the cheaper material is conclusive proof that its advocates do not wish the best material.

Heliography;—A Correction.

We have had considerable correspondence regarding the failure of some of our readers to obtain proper results with the proportions given for the "Shaweross Process" in the article on "Heliography," published November 27, 1886.

The author, Mr. Benjamin Howarth Thwaite, now informs us that there was a *misprint* in the formula as published in the Proceedings of the Institution of Civil Engineers. In the "Shaweross, or Gallic acid process," for "110 parts of water," our experiments should read *eleven hundred* parts of water. This makes quite a difference, and we do not wonder at the complaint of one party that the resulting mixture was a "pasty" rather than a liquid compound. Try it again.

A Combination of Bridge-Builders.

A plan which has been under consideration for some time was carried into effect at a meeting of iron bridge-builders on December 29 at No. 18 Broadway, New York.

This was the formation of the American Bridge Builders' Association and the adoption of a constitution and election of officers. The bridge companies entering this association are, Union Bridge Co., Keystone Bridge Co., Edgemoor Iron Co., Detroit Bridge & Iron Works, Passaic Rolling Mills, Morse Bridge Co., Cofrode & Saylor, New Jersey Steel & Iron Co., C. J. Schultz and the Phœnix Bridge Co. The officers elected at the above meeting were.—A. L. Griffin, President; Willard Pope, Vice-President, and Wm. H. Connell, Secretary and Treasurer.

This is a powerful combination and embraces the principal bridge constructing firms of the country. It is announced that the purpose of the organization is to advance the theory and practice of bridge construction by a united effort of experts in discussing, investigating and reporting upon the strength and qualities of material, on workmanship, specifications, inspection, etc.; with the end in view of securing bridge structures satisfactory alike to engineers and those who use and pay for bridges.

Much good to both engineers and bridge-buyers should certainly result from the faithful carrying out of the above programme; and American bridges, now the most scientific structures of that class in the world, will undoubtedly be still further improved under the concentrated efforts of our most experienced makers. The experience of kindred associations has demonstrated the beneficial effects of experts pooling their knowledge, experience and skill, and by a sifting process eliminating faulty features and concreting the good points into a sound and satisfactory practice, that may be still further improved. If this pooling of interests, however, includes those of a commercial as well as a professional character, the Association must look to it that the engineering world at large loses nothing by the absence of that sharp competition of rival firms which, when honestly carried out on a basis of good workmanship and perfection of detail in design, is productive of better practice and an advance in knowledge.

Snow and Salt in New York.

In the course of some articles on "Municipal and Sanitary Engineering in the City of London," published last year, we called attention to the fact that Colonel Haywood, notwithstanding his limited experience with snow storms had discovered that a plentiful application of salt and a subsequent sweeping of the melted snow into the sewers, gave the minimum amount of discomfort; while a small dose of salt as usually applied by our horse railroad companies produced a pasty mess that stayed on the streets till a thaw, mentioning at the same time that the fact seemed not to be officially known in this city. Later, referring to the practice in Paris we showed that about five ounces of salt were required per square yard for each inch in depth of snow.

The official mind of this city has not yet taken cognizance of the possibilities offered by a free use of salt *followed by sweeping* the streets. The horse railroad companies however promptly availed themselves of the information, as far as a liberal use of salt went, during the last snow storm, but failed almost universally to notice the recommendation about sweeping; only a few roads sweeping their tracks at all and those swept the freezing mixture onto the sides of the wheelway leaving all the objectionable features of salting the tracks, viz., cold feet and a liability to diptheria.

Melting the snow from a strip 21 feet wide would require about two net tons of salt per mile for each inch of snow fall, and as a man can sweep 600 square yards of fair pavement per day, the sweeping, which should not be done with the ordinary revolving broom to throw the "sposh" onto the unmelted snow on the sides of the stones, the sweeping, particularly if the sewer manholes were opened, would not be as expensive as carting away the snow, and it may be doubted if the whole operation would be as expensive to the companies as the double teams and other annoyances of the present method.

It may be objected that the proposed plan is forbidden by a city ordinance; which is also true of the present practice: one constitutes a long continued nuisance, the other might be worse for a short time.

THE Aqueduct Commission, on January 5, re-elected ex-Judge Spencer as Chairman for the ensuing year. Commissioner Ridgway, at the same meeting, again presented his plan for re-organizing the engineering department, as referred to on page 30.

The American Iron Trade of 1886.

Mr. James M. Swank, of the American Iron and Steel Association, has published a review of our iron and steel production for the last year, which shows extremely gratifying results.

Mr. Swank puts the production of pig-iron at 5,600,000 gross tons. This is a gain of 38.4 per cent. over the make of last year, and of more than 21 per cent. over that of 1882, our year of greatest production up to last year.

Steel rails, 1,500,000 gross tons, a gain of 56.3 per cent. over the make of last year, and nearly 17 per cent. over 1882. Bessemer steel ingots are put down at 2,000,000, and open hearth steel at 200,000 tons.

The statistics for 1886 are estimates of which it is said they have been estimated with care, and it is believed they will be fully verified by the official returns from the manufacturers. Mr. Swank's experience and opportunities prevent his being far out of the way, and they show that we are maintaining our position as the largest producers of Bessemer steel. England alone, is ahead of us in pig-iron production; her production last year was 7,250,657 tons. As her stock of unused pig-iron had increased from 1,809,467, in 1884 to 2,352,169 tons, in 1885 it is doubtful if her make last year will greatly exceed that of 1885, this will bring our production to within less than one and two-third million tons of hers.

During the five years commencing 1846, the first five consecutive years for which there are statistics of our production, our make of pig-iron averaged 715,951 tons against an average of 790,437 tons made in Great Britain, from that time there was no increase in our production till after 1861, our average make for the five years ending on that date having been only 713,427 tons against an average for Great Britain of 3,673,501, or in the intervening period they increased the small lead they averaged up to 1850 to one of over five times. Since 1861, we have been slowly approximating to our relative position of forty years ago, and there is no doubt that we shall soon exceed all other countries in the production of pig-iron as we now exceed them in the production of Bessemer steel, though the date can not be exactly predicted.

The development of the pig-iron industry can be roughly followed from the subjoined table compiled from Mr. Swank's "Twenty-one Years of Progress in the Manufacture of Iron and Steel in the United States," showing the world's production of pig-iron, for the years mentioned and the percentages made by the principal iron-making countries:

	World's Production.	Percentage Made by Each Country.					
		United States.	Great Britain.	Germany.	France.	Belgium.	Austro-Hungary.
1850	4,750,000	11.9	16.5				
1856	7,000 000	11.2	51.2				
1865	9.250,000	9.0	52.1			5.0	
1870	11.900,000	14.0	50.1	11.6	9.8	4.7	3 8
1875	13,675,000	14.8	46.5	14.7	10.2	3.9	3.6
1880	17,980,000	21.3	43.2	15.0	9 5	3.3	2.6
1882	20 750,000	22.2	40.9	16.5	9.8	3.7	3.4
1885	19,100.000	20.6	38.0	19.4	8.4	3.7	4.1

This shows the increase production is equal to 104.5 per cent., while our increase has been 386 per cent.

No small part of the increased lake and railroad traffic is due to the transportation afforded by the raw material necessary for the production of 5,600,000 tons of iron. It will be within the average requirements, if we assume two tons of ore, one and one-half tons of coal or coke, and one-quarter ton of limestone as required for each ton of pig-iron manufactured. This for our make of last year (noting that freight is calculated in net tons) would give over twenty-three and one-half million tons of freight to be transported, against less than three million tons in 1850.

In 1871, the total tonnage transported on the Erie canal, the New York Central, the Erie and Pennsylvania railroads was, 2,914,416 net tons. And the tonnage of the raw material of our make of pig-iron equaled nearly 5½ per cent. of the total tonnage of the country in 1885, as returned by Poor. It is to be regretted that the average haul of the ore, etc., has never been figured up, so that the contribution to our railroad traffic by this industry might be known.

The stimulating effect of that portion of this immense tonnage that seeks carriage on our lakes is shown by the fact that thirty-one vessels are now being built on our lakes from Buffalo to Milwaukee, at an estimated price of $4,000,000. These vessels have an aggregate tonnage of 66,000 tons; most are of steel or iron, and many have triple expansion engines, and it is probable that additional steamers will be commenced before the opening of navigation.

Assuming the deduction of J. S. Jeans, the Secretary of the British Iron and Steel Institute, from the practice on the Clyde to be correct, viz.; that each man employed builds fourteen tons per annum, those now building will give the equivalent of one year's labor to over 4,500 men, besides the labor and transportation employed in producing the plates, angles, etc. used in their construction.

Sewer Assessments in Fall River, Mass.

The Board of Aldermen of Fall River, Mass., at their meeting of Dec. 29th took action in regard to sewer assessments in that city, and as the subject is one of interest in every community we give the report of their proceedings at some length.

The introduction of water-works and the consequent completion and elaboration of the drainage system has brought about a discussion as to the best method of payment for the latter improvement. This has been a fruitful theme of discussion for twenty years past and the subject has been thoroughly investigated by Providence, R. I., in 1877, and by Cambridge in 1879; and also in the supplement to the first annual report of the Massachusetts State Board of Health. From these documents and local evidence and experience the Fall River committee frames its conclusions.

The cost of a sewer is dependent upon many controlling conditions; but in paying for them five different methods are now in use as follows:

First—By the city or town from a general tax levy.

Second—By assessments based upon the valuation of estates bordering upon the sewered streets.

Third—By assessments based upon the area of such estates.

Fourth—By assessments based upon linear feet of frontage.

Fifth—By the third and fourth method combined, *i. e.*, area and frontage.

The objections to these various methods may be summed up about as follows: By the first methods the tax is for the benefit of the few: persons remote from the sewers and perhaps never reached by them must pay their pro-rata share. By the second method, Lot *A* being valuable, though with a single house drain, may pay more than lot *B* with seven cheap tenements, fifty residents and four drains. By the third, Lots *A* and *B* pay as much as Lot *C*, which has upon it a tannery discharging 100 times the amount and more offensive sewage; or a vacant lot *D*, to which the sewer is no advantage, may pay more than all of them. By the fourth method the corner and vacant lots again suffer, and a lot with a single house may pay four times as much as another with two houses.

The moral of this is that sewerage accommodations should be paid for, as most other things, in proportion to value received and upon receipt of the same.

The practice of the cities of the United States, so far as the latest statistics go to show, may be summarised as follows: (see Cambridge report, answers to inquiries).

Of a whole number of	79
Those cities having no systems were	13
Having systems	66
Paying by general tax	13
Assessing benefits	53

Of this fifty-three, those

Assessing the whole tax were	14
" three-fourths	15
" front feet to three-fourths total cost	10
" one half and less than three-fourths	12
" one-half	2

Thus, of 66 cities, 59 per cent. assess three-fourths or more; 18 per cent. assess one-half to three-quarters, 3 per cent. assess less than one-half, and 20 per cent. assess nothing.

The prevailing rule among those which clearly state their practice is to divide according to frontage. Seventeen out of twenty-five do so. Ohio has a law limiting the assessment by this method. All of the 17 are above 80 cents per front foot, and most are over $1.50 per front foot for each side of the sewer. Providence and Brookline having given considerable attention to the subject conclude it better to combine the two plans of frontage and area.

Providence assesses 60 cents per front foot and one cent additional per square foot running back not over 150 feet. On a lot 109x150 feet this is equivalent to $2.10 per front foot.

Brookline assesses 75 cents per front foot, and three-quarters of a cent. per square foot within 100 feet of the street, or equivalent to $1.50 per front foot.

Boston formerly divided the three-quarters of the cost according to the valuation of the abutting estates. Within a few years she has adopted the area division of three-quarters for lots 100 and 150 feet deep, and makes allowance for corner estates, courts and side hills.

The practice of Fall River has been to require "a reasonable sum" to be paid for connecting with a city sewer; but this sum was so indefinite that the ordinance has given cause for much uncertainty and trouble. The committee in suggesting a remedy recommend the mode of assessment of betterments under the Public Statues. But in the five cities reporting as having adopted this plan the price charged ranged from $25 to $200 for each connection; and as only 257 permits were issued in 1885 in Fall River, the returns would be so small from this plan that the cost of construction would have to be defrayed from tax levy as at present.

To January 1, 1886 the total length of sewers constructed in Fall River was 158,962 feet, costing $844,717.82. Deducting from this amount $100 each for 363 catch-basins and figuring on a double sewer connection at each 50 feet of length, there would be 6,358 entrances to be divided over $606,313.55 (allowing the city to pay one-fourth). This would make the payment required of each abuttor for entering a sewer only $95.36. The average cost of sewer construction during the past sixteen years was $5.36 per lineal foot; an assessment of three-ourths of this would equal $4.02, or $2.01 for each side. Under the system of Providence, R. I., $2.10 is collected for each side; Brookline, Mass., collects $1.50 for each side and Cambridge, Mass., the same. Considering the

extra cost of Fall River sewers due to the granite underlying almost the entire city, the expense of construction is greater than in the towns named.

The committee therefore recommends as a just and equitable assessment for Fall River, a sum of $1.75 per lineal foot for each side or $3.50 for both sides, based on a combination of frontage and area, in the proportion of 75 cents per front foot and one cent per square foot of area. The frontage plan will discriminate against lots with wide fronts and shallow depth; while the area plan will be against narrow fronts and great depth; but by combining the two this discrimination is expected to be equalized and corrected. The city is to bear never less than one-fourth of the expense and in especial cases one-half.

The following proposed ordinance is intended to cover the needs of the new regulation.

CITY OF FALL RIVER.

AN ORDINANCE IN RELATION TO THE PAYMENT FOR AND ASSESSMENT OF SEWERS.

Be it ordained by the City Council of the City of Fall River as follows:

Section 1. Not less than one-fourth of the cost of making and repairing each sewer shall be borne by the city; and the remainder, together with a proportional part of the charge not already assessed of making and repairing other sewers through which the same discharges: shall be assessed according to law: provided that the whole amount of assessments certified for such discharging sewers shall in no case exceed three-fourths of the expense of their construction and repair; and provided further that no estate shall be assessed until it can be drained into the sewer, and that no estate shall be assessed more than once for the same benefit.

Section 2. In order to assist the Mayor and Aldermen to ascertain the proportional part to be assessed and certified according to law, the City Engineer shall prepare and submit to them an accurate account of the cost of making and repairing each sewer hereafter constructed, and of any other sewer of which the Mayor and Aldermen shall request such an account, together with a plan for assessment, showing in detail the estates deriving benefit therefrom, with their frontages and areas (within one hundred feet of the street), and the names of the owners thereof. He shall show on said plan three-quarters of the cost of said sewer; and after delineating on said plan such system of sewers, as, in his judgment, will eventually discharge into this sewer, he shall estimate and enter thereon what proportion of the said three-quarters of the cost should be reserved for assessment along such future sewers. He shall also enter on the plan a list of the sewers through which the said sewer discharges, with an estimate of its just proportion of the charge not already assessed, of such discharging sewers; and he shall enter on the plan the balance remaining after deducting the said proportion reserved from the said three-quarters of cost, and shall add thereto the said proportion of the charge of said discharging sewers. The sum thus obtained shall be designated pr minently on said plan, " the total sum to be divided proportionally among estates benefitted, according to law.

Section 3. He shall prepare and submit to the Mayor and Aldermen a schedule, dividing the total sum shown on the plan provided by Section 2, according to the following method: Four-tenths of the benefit, according to the relative frontage of each estate on the street where the sewer is, and six-tenths according to the relative area of each estate within 100 feet of such street. The area of corner lots shall be measured to the line bisecting the angle formed by the street lines.

Section 4. The amounts assessed and certified by the Mayor and Aldermen shall be entered upon the plan prepared for assessment.

Section 5. Plans and descriptions of all main drains and common sewers belonging to the city, with a true record of the charges of making and repairing the same, and all assessments therefore shall be kept in the rooms occupied by the City Engineer. Said rooms shall be for the purposes of this ordinance, a part of the office of the City Clerk.

Section 6. Section 25, Chapter 50, of the Public Statutes, is hereby accepted.

Section 7. All monies received into the City Treasury under the ordinance for the assessment of betterments on sewers constructed previous to January 1st, in the year 1887, shall be paid over annually by the City Treasurer to the Commissioners on the Sinking Funds, for the payment or redemption, first of any existing sewer loans, contracted prior to said January 1st, A. D. 1887, and secondly for the payment or redemption of the Municipal debt of the city.

Section 8. All ordinances or parts of ordinances heretofore, passed by the City Council of the City of Fall River are hereby repealed in so far as the same conflict with the provisions of this ordinance.

Aqueduct Commission.

At the meetings of December 22 and 27, 1886, the first business was the report of the special committee appointed to confer with the Civil Service Supervisory Board. This committee recommended the establishment of the grade of Axeman, not subject to civil service rules; this was adopted and changes made accordingly in late appointments. The next grade above, or Chainman, is subject to the rules.

Messrs. E. F. Playle and Wm. D. Kelly, Jr., were ordered up for examination for promotion to grade of Assistant Engineers to fill vacancies; and Maurice A. Viele, now a chainman, to be examined as to his qualifications as rodman. It was ordered that shanties be built at the mouths of shafts, at a cost not exceeding $70 each, with stove, to enable the engineers and inspectors to change and dry their clothing.

The change in the line of the New York & New England R. R. in the Croton valley was then discussed. The aqueduct and railroad committees have been in conference and have agreed upon $110,000 as the total cost of the proposed change, with $2,500 added for legal charges.

Chief Engineer B. S. Church and Principal Assistant Engineer Pugsley were designated as members of the Examining Board for promotion, on the part of the Aqueduct Commission.

An amendment to the by-laws was offered by Commissioner Ridgeway, and laid over under the rules, which proposed to give to a Committee on Construction of five members "full powers of direction and supervision over the works of construction, and over the engineers, officers and employés engaged therein, and the offices and property in their charge, subject, however, to the authority and direction of the Aqueduct Commissioners at all times." This committee would seem to have absolute power in the direction named; could give orders through the chief engineer or his principal assistant, or suspend any engineer or employé of the engineer corps.

Cast-iron or Steel Piles.

Prof. S. W. Robinson, of the Ohio State University, has designed an improved form of iron piles intended for use in positions where hollow iron piles would be liable to injury from freezing, or from the impracticability of renewing preservative coverings on the inside face.

The cast-iron pile, in section, is represented by crossing at right-angles two I-beams of equal depths and with heavy flanges, these last about one-third as wide as the beam is deep. Prof. Robinson claims that he has so disposed the material as to gain the greatest strength with "less material than has heretofore been used in such piles." The wrought-iron or steel pile is made by bending two I-beams to a V-shape with a short flat base and then riveting them together. These piles would be used in lengths of 12 or 15 feet, or by coupling them together when greater lengths are required.

A strong company has been formed to introduce these piles, for which they claim a multitude of possible applications, either singly or in groups. The wrought-iron type here described is very suggestive of some of the forms of bridge posts described during the famous "Phœnix column controversy" of some years ago.

PERSONAL.

PARKER SPOFFORD, C. E., has prepared plans for a water supply for Bucksport, Me.

E. H. BECKER has been appointed Assistant Chief Engineer of the Montana Central R. R. by COL. J. T. DODGE, Chief Engineer.

P. F. BARR has been appointed Chief Engineer of the Chicago, Santa Fé & California R. R., with office in the Exchange Building, Chicago.

J. S. WINSTON, one of the members of the contracting firm of Winston Bros., which had contracts for tracklaying on the Northern Pacific R. R., died recently at Richmond, Va.

MARTIN KELLY is General Manager of the Northwestern Construction Co., with offices at Wyandotte, Kan. MAJOR E. S. W. DROUGHT will have charge of track and tracklaying forces: and GEO. H. ANTHONY will have charge of material and supplies.

WM. F. GARRISON, senior member of the firm of Guild & Garrison, extensive steam pump manufacturers of Brooklyn, N. Y., has recently returned from Europe after a sojourn of seven months.

THE Mayor of Haverhill, Mass., in his inaugural address has recommended the appointment of a City Engineer; the salary need not exceed the sum expended yearly for plans and surveys.

E. B. WINGATE, Chief Engineer of the St Louis, Kansas & Southwestern R. R., whose headquarters are at Caldwell, Kan., was married recently at Kansas City, Mo., to Miss Kate Gough, of Caldwell.

COL. JULIUS W. ADAMS, has been appointed by Commissioner Newton as Consulting Engineer to the Board of Public Works of New York City. This is the position COL. ADAMS long and most acceptably held until relieved in the deals of the late Commissioner Squire, and his many friends rejoice to see him back in his old place again.

CHARLES H. SHERRILL, the noted representative of the Central Pacific Railroad interests in Washington and a successful "promoter of enterprises," died in that city on January 4. MR. SHERRILL was born in Cuba, Allegheny Co., N. Y., about 73 years ago. He was quite a prominent state politician and at one time a Canal Commissioner of the State of New York. He went to Washington in 1861, was a contractor for the construction of city works, and about that time formed an acquaintance with Messrs. C. P. Huntington, Charles Crocker and Leland Stanford, the projectors of the Central Pacific, and ever after was their trusted agent in all necessary lobby work at the Capitol.

JOHN S. NEWBERRY died in Detroit, Mich., recently in his sixty-first year. He was a member of the firm of Newberry & McMillan, capitalists, and was interested in many railroad and other enterprises in Michigan, having established the Michigan Car Works, and being Secretary and Treasurer of the Detroit, Bay City & Alpena R. R., and a director of the Detroit, Mackinaw & Marquette R. R.; the Detroit National Bank, the Hamtrack & Detroit Transportation Company, the Detroit & Cleveland Steam Navigation Company, the Vulcan Furnace at Newberry, in Chippewa County, the Detroit Car Wheel Company, and the Baugh Steam Forge. Recently he gave $10,000 to the Detroit Art Museum, and with James McMillan gave $100,000 for the establishment of a free homœopathic hospital. In 1878 he was elected to Congress, and in 1881 was prominently urged for a position as Secretary of the Interior in President Garfield's Cabinet. He was known as one of the foremost admiralty lawyers in the country.

DR. ISAAC LEA, the naturalist, who died in Philadelphia on December 8th, aged ninety-four years, had been well honored in his life by learned societies. He was ex-President Academy Natural Sciences; Vice-President American Philosophical Society; Doctor of Laws from Harvard University in 1852; Honorary Member Asiatic Society, Bengal; Member Royal Physical Society, Edinburgh; Member Linnæan Society, Bordeaux; Member Imperial Society, Moscow; Honorary Member Boston Society Natural History, Member Royal Academy Sciences, Turin; Honorary Member Royal Zoölogical Society of Ireland; Member Zoölogical Society of London; Honorary Member Physical and Natural History Society, Geneva; Member Geological Society, Boston; Member Natural History Society, Athens, Greece; Member Societé Polytechnique, Paris; Member Societé Imperiale des Sciences Naturelles de Cherbourg; Member Imperial Royal Zoölogical Society, Vienna; Member Natural History Society, Wurtemburg; Member Societé Paleontologique de Belgique; Member Natural History Society, Montreal; ex-President and Fellow American Association for the Advancement of Science; Member British Association, 1832 and 1833; Honorary Member Historical Society, Buffalo, N

Y., Honorary Member California Society of Natural History; and Member New York Academy of Science.

H. H. ELLIOTT, Savannah, Ga., has been appointed Chief Engineer of the Kansas City & Birmingham R. R., to succeed CAPT. JOHN A. GRANT. He was Capt. Grant's chief assistant on the Mississippi Valley R. R.

SULLIVAN HASLETT, late Mem. Am. Soc. C. E., died at his residence in Brooklyn, on January 4th, after an illness of some months. MR. HASLETT, the son of the late Surgeon John Haslett, U. S. N., was born in Brooklyn, August 23, 1843. He graduated from the University of New York in June, 1868, with the degree of C. E., and in the same year commenced the practice of his adopted profession as a chainman on the West Shore Hudson River R. R.; in 1869 he was engaged on the New Jersey Western R. R. and New Haven, Middletown & Willimantic R. R., filling the position of assistant engineer on the last named road in 1869-70 and 1871. He was division engineer in charge of the Lyman & Rapallo Viaduct from 1871 to 1873, and asistant engineer for the Hoboken water surveys in 1873; resident engineer Anacotta bridge, Washington, D. C., 1874-75; in charge of Waban bridge, new supply Boston water works in 1876. From 1877 to 1879 he was resident engineer for Clarke, Reeves & Co., in the construction of the Gilbert Elevated railway in New York City. In addition to these works, MR. HASLETT was contractor on a branch of the St. Louis & Iron Mountain R. R. in Missouri, consulting engineer for the Chautauqua Lake R. R., and as engineer connected with the construction of the Cramp Dry Docks, in Philadelphia, and the surveys for the Blackwell's Island bridge and the Kings Co. Rapid Transit R. R. He was a member of the firm of Haslett & Van Horne, of New York City, and also of the contracting firm of C. O. Richards & Co., of same place. MR. HASLETT, though a comparatively young man, was possessed of marked ability in his profession and most acceptably filled a number of prominent positions; his work was thorough and painstaking and he won the respect of a multitude of warm friends by his personal good qualities as a man and an engineer. He was elected a member of the American Society of Civil Engineers on June 4, 1879.

American Society of Civil Engineers.

The Society held its regular meeting on January 5, Vice-President Rowland presiding. The Secretary announced the death of Mr. Sullivan Haslett, member of the Society, and it was ordered that the usual committee be appointed to prepare a memoir. In regard to the next Annual Meeting, while no official announcement was made to that effect, it was generally hinted that the excursion of the occasion would be over the new road of the Suburban Rapid Transit R. R. Co. and that the members would then very likely take a steamer down the river and, stopping at several points of interest, finally visit Bedloe's Island and the Statue of Liberty.

The regular business of the evening was the reading by the Secretary of a number of written discussions on the late paper of Mr. E. Bates Dorsey on "Irrigation."

The contributors were Messrs. Fred Eaton, H. A. Brainard, A. D. Foote and C. L. Stevenson. The authors generally testified to the great benefits of irrigation in the western states and territories; although Mr. Brainard showed that some judgment should be used and that certain products, especially fruits, were actually injured thereby. The proper duty of a cubic foot of water per second was the burden of the discussion; and the evidence presented showed a diversity in this respect ranging from 56 acres in Colorado to as much as 1,500 acres on fruit ranches on the Pacific Coast irrigated by water distributed in iron pipes.

The following gentlemen were declared elected to the several classes:—

FOR MEMBERS:—Addison Connor, (Tufts Coll. 1869 and Mass. Inst. Tech. 1871.) formerly engaged on Additional Water Supply, Boston, Mass., and Holyoke Water Power Co., Holyoke Mass.; Resident Engineer Northern Pacific R. R., Assistant Engineer Missoula Division N. P. R. R., recently Assistant Engineer Department of Public Works, New York City; now engaged on the Rectification of the Missouri River, Plattsmouth, Neb.; Samuel Henry Shearer, formerly Assistant Engineer Indianapolis, Delphi and Chicago R. R.; Chief Engineer Toledo, Delphos and St. Louis R R.; Division Engineer St. Louis, Fort Scott & Wichita R. R.; recently Assistant and now City Engineer, Indianapolis, Ind.; Frank Ormond Whitney, (Worcester Tech. School 1871.) (Elected Junior May 3d, 1876.) Assistant Engineer, City Surveyor's Office. Boston, Mass.

FOR JUNIORS:—Robert Cook Clarkson, engaged on Kings Co. Elevated R. R., now Assistant Engineer with Wilson Bros. & Co., Philadelphia, Pa. Henry Wilson Hodge, (Rens. Pol. 1885.) with Phœnix Bridge Co.

The Illinois Society of Engineers and Surveyors.

The second annual meeting of this society will be held in Champaign, Ill., on January 26, 27 and 28, at the University of Illinois. The last meeting, in February, 1886, was a successful beginning and the prospects for the forthcoming session promise a still more interesting and profitable gathering of the engineers and surveyors of Illinois. The programme presented includes papers on surveying, city engineering, drainage and mining engineering. For further information address the Executive Secretary, A. N. Talbot, Champaign, Ill.

Association of County Surveyors and Civil Engineers of Indiana.

This Association will hold its seventh annual meeting at Indianapolis on January 18, 19 and 20. Papers will be presented on surveying, railroad engineering, highway bridges, city engineering, perpetuation of government corners, tile drainage, boundaries of Indiana, descriptions in deeds, etc., by Messrs. Campbell, Spencer, Hardman, Osmer, Lesley, Alter, Saunders, Fatout, etc. Lewis S. Alter, Corresponding Secretary, Remington, Ind., will supply any further information desired.

Annual Meeting of Mining Engineers.

The Forty-Seventh Annual Meeting of the American Institute of Mining Engineers will be held at Scranton, Pa. beginning Tuesday evening, February 15, 1887.

Hotel headquarters will be at the Wyoming Hotel (rate $3,00 per day); no special railway facilities will be furnished; Mr. E. S. Moffat is Chairman of the Local Committee and will answer all communications concerning arrangeements, rooms, etc.

No papers are yet announced by title, but those proposing to contribute are invited to send in an abstract at least as soon as possible to Mr. R. W. Raymond, Secretary.

Illinois Tile-Makers' Association.

The ninth annual meeting of the Illinois Tile-Makers' Association will be held at the State House, Springfield, Jan. 18 and 19, 1887. The programme, in addition to discussing and question box, embraces, as among principal addresses, the following: "Methods of Drying Tile," by J. J. W. Billingsley, of Indianapolis, Ind.; "Wet and Dry Seasons," by Capt. J. M. Adair, Springfield, Ill.; "Drainage Districts of Illinois," Prof. I. O. Baker, Champaign, Ill. *Discussion of Drainage Laws*, led by Hon. M. B. Thompson, Urbana, Ill.; "An Ideal Tile Factory," J. W. Penfield, Willoughby, Ohio; "Chemistry in Tile Making," Dr. R. T. Brown, Indianapolis, Ind.; "Making Large Tile," Alex. McLean, Bardolph, Ill.; "*Science Involved in Drainage*," D. W. Stookey, Buffalo, Ill.; "Thorough Drainage," Prof. G. E. Morrow, Champaign, Ill.

Connecticut Association of Civil Engineers and Surveyors.

The third annual meeting of this Association will be held at Hartford, Conn., on January 11 at the office of C. H. Bunce, City Engineer. Papers on "Tunneling," by B. H. Hull, and on "Iron Bridges with Concrete Floors," by B. K. Field, will be read in addition to the regular business. The Secretaries are D. C. Sanford and F. Floyd Weld.

CORRESPONDENCE.

A Contractor Wanted.

MANISTEE, MICH., January 3, 1887.

EDITOR ENGINEERING NEWS:

This city has been many years behind the times in the way of public improvements, and six months ago it had but eighty rods of paved street. Now it is beginning to wake up. This fall about 14,000 sq uare yards of cedar block pavement was laid, and provision has been made for the coming season for about 24,000 square yards of pavement, and one and three-quarter miles of sewerage, ranging from 9-inch pipe to 40" × 60" brick. An experienced and reliable contractor with some capital might find a good opening here. Please don't read this out loud, for it might bring me five hundred letters to answer with no stamps enclosed to pay postage.

The paving we have just completed was the cheapest of the kind that I ever heard of. Six-inch cedar blocks on 1-inch pine flooring on 5 inches sand, with 4" × 18" pine curbs, including all excavation, for 72¼ and 73 cents per square yard.

Yours truly,
E. W. MUENSCHER,
City Engineer.

More Important Features of Large Reservoirs for Irrigation.*

The author, having recently had to visit and study a large number of reservoirs, has noted some points which he thinks deserving of attention.

The weight of masonry dams has generally hitherto been taken at 125 pounds per cubic foot in calculating their stability. This is too little, and from 137 pounds to 143 pounds is the weight usually adopted now. On the other hand, 62.4 pounds per cubic foot is still taken as the weight of water, whereas the author's experiments have clearly demonstrated that turbid water, such as is often found in reservoirs, weighs from 63 pounds to 75 pounds per cubic foot. While, therefore, 62 4 pounds may safely be taken for cases where flood waters are excluded, a higher value should be adopted where these are admitted to the reservoir. It has been found on calculating the stability of certain dams, taking 68.6 pounds as the weight of water, that the pressures and tensions at the external and internal faces of the dams are from one-fourth to one-third greater than when 62.4 pounds is adopted.

Three dams in Algeria have recently failed, the Habra in 1881 and the Cheurfas and Sig dams in February, 1835. At Hamiz the water was admitted into the reservoir in 1884, but the dam having shown symptoms of failure the water was at once run out, and an immense retaining wall was built to arrest the movement. The water was admitted into the Cheurfas reservoir in January, 1885, and it at once began to make its way through the permeable ground at one end of the wall. The sluice at the bottom of the reservoir could not be opened, and after a time a large quantity of

*From the Foreign Abstracts of the Institution of Civil Engineers.

earth was washed away, carrying with it some 30 feet of the dam. The water washing through this great aperture caused a flood in the river below. Some distance down stream the Sig reservoir was situated, and the flood pouring down topped the dam by 18 feet and overthrew it. When the Hamiz dam failed it was subject to a pressure of 157 pounds per square inch and a tension of 43 pounds per square inch, which the author considers too high for mortar, which, though of excellent quality, has not had sufficient time to set. The author points out that a slight increase in the height of the water in the reservoir above that for which a dam is calculated produces greatly increased strain upon the work, and therefore means should always be adopted to ensure that the water will not rise above the intended level, and he recommends that dams should be built circular on plan, so as to act as arches, particularly if the foundations are not very solid, and instances that of Chéliff, which is 59 feet high, and has twice had water running over it to a depth of 13 feet. This dam is founded upon beds of sandstone, alternating with clays, which formed a very unreliable foundation; nevertheless the dam has never shown any sign of failure, though subjected to severe compressive and tensile strains, and the explanation of this fact is that the dam is formed in an arc of a circle of 492 feet radius, the length of the arc being 260 feet.

The highest earth dam in the world, with the exception, perhaps, of some in India, is said to be that of Oued Meurad in Algeria, which has a height of 95 feet. This was completed in 1864, and is in very good condition. A few fissures have appeared at the top, and have been filled in with masonry. The bank stands upon a bed of basaltic salt, no excavation having been made to receive it. About three gallons of water per second leak through, but without endangering the bank. It was constructed in layers, but these, instead of being horizontal, were normal to the outer slope. When the bank had been completed up to a certain height, the reservoir was allowed to fill. This caused the bank to settle down, and when it stopped settling the work was resumed and the bank completed. This is a somewhat dangerous method of construction, but produces a very solid bank.

Another remarkable dam is that of St. Christopher upon the Marseilles canal. This was originally simply a bank of rough stone 65 feet high, for carrying the canal across the valley, and constructed with very little care, without any intention of using it as a reservoir dam. When it was determined to adapt it to this purpose the water-tight lining of the canal was removed, and the turbid water allowed to sink into the dry stonework. This produced considerable settlement, but at the same time filled up the cavities with deposit. Water was then gradually let into the reservoir. At first large quantities made their way through the dam, but the amount of leakage diminished by degrees, and the inner face of the dam was then covered with good masonry 10 feet thick at the bottom and 1½ feet at the top. This was expected to render it water-tight, but did not have this effect, and upon readmitting the water large fissures appeared on the face, particularly near the bottom. Several rows of piles were then driven near the foot, and the cracks were filled up, and the bank is now practically watertight.

A novel method of construction has been adopted at the Puentes reservoir in Spain. The rocks on either side of the valley are very solid limestone, but the bottom of the valley consists of sand and gravel, which rests upon a bed of marl. Arches have been thrown across the valley abutting against the rocks, and the dam, which is of masonry, is supported by them, and only the filling under neath the arches rests upon the bad foundation.

The author points out that storage reservoirs have a very beneficial effect upon climate, as has been proved in Algeria, where the result of storing up the flood-waters in winter and using them for irrigation in summer has been the drying up of the marsh lands and laying them under cultivation, with a marked improvement in the health of the country.

Masonry dams frequently leak a good deal when first constructed, and this need not cause alarm, as by degrees the leakage diminishes. If, however, the ground is permeable and serious amount of water is lost by filtration round the end and underneath the dam. When flood-waters are stored in reservoirs, a large amount of deposit takes place, and this may be disposed of for irrigation in winter, when it serves as a manure, but in summer clear water only must be used. Special arrangements for discharging the water are necessary in such cases.

The silting up of irrigation reservoirs is one of the most serious problems in connection with them, and it is sometimes thought that where the reservoirs are fed by mountain torrents bringing down stones and boulders, they would be filled up with these materials, but the author's observations lead him to the conclusion that this is not the case, but that detritus of this description is deposited in the beds of the stream above the reservoir, and only fine stuff is carried into it. This latter, however, amounts to a very considerable quantity. The annual amount of deposit at the Habra reservoir is 4.44 cubic feet per acre of gathering ground; at Sig 4.05 cubic feet; at Tiélat 24 cubic feet; and at Djidionia 43 cubic feet. Various methods of washing out the deposit are discussed in the paper, which concludes with remarks upon the value of water for irrigation, and a table giving particulars and cost of twenty-one reservoirs in different parts of the world.

WATER.

GREEN ISLAND, N. Y.—A sewerage system is projected.

NEWPORT, R. I.—The Mayor says that the sewerage is in a satisfactory condition and recommends that bonds be issued for constructing the main trunk sewer.

BAD WATER AT WOODHAVEN, L. I.—Dr. Nadal, Health Officer of Jamaica, L. I., states that he has found disease-breeding impurities in water submitted to him for analysis from wells at Woodhaven.

THE LITTLE RIVER DITCH, near Fort Wayne, Ind., has cost to date $20,355.43, according to the late report of Ditch Commissioner Ed. Ely. Three iron dredgers are at work on the river and its branches.

SANFORD, FLA.—A report on a proposed sewerage system has been made to the City Council by D. B. Lewis, civil engineer. He recommends the expenditure of about $4,000 for drains and $5,500 for pipe sewers. The sewage to be disposed of by surface irrigation or by discharge into the deep water of the lake.

CARTHAGE, ILL.—An abundant flow of water has been struck by the artesian well at a depth of 965 feet; the water is wholesome with a very slight taste of sulphur. By the advice of the State Geologist, Professor J. H. Worthen, the well will be carried down to at least 1,000 feet.

DAM AND RESERVOIR AT SCRANTON, PA.—The contract for the building of a dam and reservoir on Oak run at Scranton, Pa., has been awarded to Messrs. Burk Brothers, of Scranton. The work will be executed in accordance with plans and specifications prepared by Mr. E. Sherman Gould, late of the Croton aqueduct, who will have the supervision of the work.

The construction of this dam is the first step in the project for increasing the supply of water furnished by the Scranton Gas & Water Co. to the city of Scranton; an increase rendered necessary by the rapid growth of the city and the development of its industries. The work above mentioned is to be shortly followed by the construction of a still more important dam, to be located on Roaring brook, the main stream from which the supply is drawn; the plans are already partially prepared.

BOSTON WATER SUPPLY.—A petition has been sent to the Massachusetts legislature, asking that the water of the Shawsheen river be granted to the city of Boston for an additional supply; the petition is signed by Hugh O'Brien, mayor of Boston; Mark F. Burns, mayor of Somerville; Eugene F. Endicott, mayor of Chelsea, and Thomas Leavitt, Chairman of the Everett Water Commissioners.

VALLEYFIELD, ONT.—The new water-works were put in operation on December 23. The supply was formerly taken from the Beauharnois canal, but the quality and quantity and the trouble and expense of obtaining it, caused considerable dissatisfaction and a company was organized to procure a better supply. The works were commenced in June, 1886, and were completed recently; a plentiful supply of pure water has been obtained. The works comprise a reservoir; two duplex pumping engines, supplied by the George F. Blake Manufacturing Co., of Boston, with a capacity of 1,250,000 gallons per day; six miles of pipe; and 45 double nozzle hydrants. The pressure is 140 pounds.

WATER SUPPLY OF BROOKLYN, N. Y.—In his message to the City Council the Mayor calls attention to the question of the water supply. He says, "The daily consumption is 45,203,227 gallons, while the minimum supply in the early fall season of drought is but 45,000,000 gallons daily. The heavy rainfall of the year alone saved the city from a water famine. Now that the conduit line is practically secured, no time should be wasted in approving the plans and authorizing the raising of the necessary money, in order that there may be no delay in extending the water system."

DRAINING JERSEY MEADOWS.—Prof. Geo. Cook, State Geologist of New Jersey, has for years been recommending the drainage of the valley of the Passaic river above Little Falls. The dam of the Beattie Manufacturing Co. has been in the way, and has brought about extensive tracts of marsh land above it, containing in all over 12,000 acres. The State has sanctioned the lowering of this dam by 7 feet, and though the mill company has asked for $ 50,000 damages, the Commission appointed has just awarded them $35,000. An appeal is expected from this decision. The drainage of this land is required for sanitary as well as agricultural reasons, and it is believed that work will be commenced in the spring.

CHICAGO, ILL.—There are serious fears of a water famine. The reports from the "crib" on Jan. 4th, were that a great deal of difficulty was being experienced in keeping the gates clear of anchor ice, while the floating ice was also giving considerable trouble. A device was in use by which a chain was kept in motion through the gate openings to remove the forming anchor ice, but it formed on the gate walls even, and the remedy was consequently only a partial success. The outside or floating ice was being chopped and pounded by the tug Monitor and kept away from the gates. But the task was almost herculean, for the suction incident to the rushing in of 110,000,000 gallons of water in twenty-four hours was almost irresistible. The day passed, however, without any serious mishap, without the gates becoming stopped, and without its being necessary to summon extra help from the shore.

BLAIR, NEB.—Some time ago the city entered into a contract with Fairbanks & Co. for a water supply of 800,000 gallons per day, the works to be completed by January, 1887. The company only obtained a supply of 200,000 gallons per day, from 19 1½-inch wells instead of 20 3 inch wells as required by the contract, but stated that a greater supply could not be obtained and demanded that the city accept the works, and on the refusal the superintendent locked up the pump house and reservoirs. The city then contracted with Joseph Burns, of Lincoln, Neb., based on the terms of the former contract, for $4,221.50: he completed his work in the fall and allowed the city the use of the works for some months before asking for a final test. The works were tested by John Jenkins, M. E., of Omaha, who reported a daily supply of 1,084,320 gallons.

WATER SUPPLY OF PHILADELPHIA.—The South Mountain Water Company is again energetically pushing its project before the City Councils of Philadelphia, for a new water supply. The proposal is as follows:—

"We ask for a lease of the water-works, for fifty years. We will pay for the lease, from the time we get possession until 1910, $500,000 a year, and after that one-half of the gross receipts of water rates, less $2,000,000 annually. During the first three years we will spend $5,000,000 on storage and distribution, $2,000,000 of which will be paid right down at the time of possession. The company will spend during the lease, for further extension, $6,000,000, and will build three conduits, one to completed in three years at a cost of $11,000,000, the second in 1915 at a cost of $11,000,000, and the third later,

twice as large, at a cost of $19,000,000. This in all makes $120,000,000. The total receipts during the lease, from a calculation on the increase in population, will be about $236,000,000. That leaves the company $116,000,000, out of which it pays for operation."

The advocates of the new supply advanced many reasons why this work should be commenced at once, and in answer to queries, said they could easily borrow the $16,000,000 required to commence, at 5 per cent. The opposition thought that the city was taking all the risks and the company would have the handling of the present handsome profits of $1,000,000 per annum. No result has yet been arrived at.

LAKE VIEW, ILL.—The city has experienced the usual winter trouble with its water supply. The town has two lake inlets for water and one shore inlet, and uses about 3,000,000 gallons per day at this time of year. The lake inlets are relied on for the ordinary supply, and as these are liable at any time in winter to be more or less clogged by anchor ice the shore inlet is the resource. Mr. John W. Alvord, the Town Engineer, stated in explanation of the present trouble, that the town last fall began the building of a new pier into the lake and this work was not completed until a short time ago. The new pier necessitated the extension of the shore inlet, and for three weeks past workmen had been engaged in laying new pipes for that purpose. This closed the shore inlet, and during the last few days the anchor ice had formed so rapidly as to cut off the pressure in the main pipes. He said, however, that the supply had at no time been wholly stopped and that now no further trouble is apprehended. The extension of the shore inlet would be completed in a few days with favorable weather and then the water works would be able to meet all the demands upon them without difficulty.

WATER SUPPLY OF WASHINGTON, D. C.—Capt. Symons states as follows in a recent report: "It is my belief that a very large proportion of the water wasted in this city is lost from leaks in the mains and service pipes. Under these street pavements, the water from leaks cannot rise to the surface and develop itself, but finds its way into the nearest sewer. A recent experience on L street northwest, between Twelfth and Thirteenth streets, illustrates this. A large break occurred in the street, the asphalt pavement dropping down into a hole, from which the earth had been washed. This hole was about 6 feet in diameter, and 6 feet deep. Investigation showed that the service pipe was rotten and broken, and the water had been running for months. When the new works are put into operation, and the head of water largely increased throughout the city, it is believed that many other leaks will be developed and old ones aggravated."

WATER SUPPLY FOR SYRACUSE, N. Y.—J. W. Rutherford, civil engineer, of New York City, has been in Syracuse in the interest of a syndicate which proposes to put in water-works; he will make plans and estimates and a report. The syndicate would purchase the plant of the Syracuse Water Co. Mr. Rutherford thinks that the supply should be filtered. Mr. Crow, who has submitted a proposition backed by Boston capitalists, has been looking over the ground with Mr. Inman, negotiations are pending with the old company. The Central City Water-Works Co., President Frank B. Merrill, received its franchise in March, 1885, requiring the supply to be taken from Oneida, Cazenovia or Skaneateles lakes or the Tully ponds; the company claims to have complied with all the conditions as far as possible and accuses the council of bad faith in not designating one of the sources of supply; a claim for damages will be made, and it is thought the company has a strong case. The Salmon River Water Co., President, William A. Sweet, has done much work, and will produce complete reports and estimates when its case comes up for presentation. The Syracuse Water Co. states that it will go ahead as fast as the council and the State Board of Health will permit; a committee of the company has recommended the building of a reservoir in the Cardiff valley which could supply by gravity 31,000,000 gallons daily. It is recommended that a single pipe of 15,000,000 gallons daily capacity be first laid from this reservoir to the city, to be followed by a second when necessary; also that for high water service a system of pumps, standpipe or reservoir be constructed, with at least seven miles of mains. The report of the committee provides for about 35 miles of additional mains in the city and in Geddes and Danforth, and for replacing all existing imperfect wrought-iron or cement-laid mains by cast-iron pipe. With these additions the city and suburbs would have about 79 miles of mains.

NEW WATER-WORKS.—Waco, Tex. The Waco Water Co. has 6 miles of pipe on the ground and 8¼ miles of 4-inch to 14-inch in course of delivery; the Matthews hydrant will be used; a pumping engine of 2,000,000 gallons capacity will be put in; the reservoir has a capacity of 3,000,000 gallons, and an elevation of 140 feet.—Moberly, Mo. The Wabash, St. Louis & Pacific R. R. Co., tiring of the trouble with the water company will enlarge its reservoir so as to give a supply during any drouth, and will not take any water from the company.—Geneseo, N. Y. The vote on water-works has resulted in a large majority in favor of the appropriation, the limit is $50,000.—Covington, Ky. A vote has been carried to build a complete system for $600,000; the reservoir will be eight miles from the city; a commission has been appointed to attend to the issuing of bonds and the selection of a site.—Woodstock, Vt. Works will be built next spring; a reservoir with a capacity of 2,000,000 will be constructed 260 feet above the village, the dam will be 80 feet long and 20 feet high; an 8-inch main will be laid and 26 hydrants set; the supply is to be taken from a brook one mile from the village.—Hiawatha, Kan. The vote for $50,000 for water-works has been carried by a large majority.—Helena, Mont. The $500,000 contract has been declared void and the construction of works is postponed.—Lenox, Mass. The water company will build a larger reservoir and lay larger mains.—Atlantic, Ia. $6,000 will be expended in improving the water-works.—Negaunee, Mich. The supply is to be extended 1,000 feet into Teal lake, to ensure pure water.—Central City, Neb. $7,000 will be spent in the spring in improving the water-works.—Keene, N. H. The new works are estimated to cost $37,000.—Tom's river, N. J. Address John P. Haines.—Americus, Ga.—Highland, Dak.—Bucksport, Me.—Ponca, Pierce and Norfolk, Neb.

WATER SUPPLY FOR ALLEGHENY, PA.—Superintendent Armstrong presented to the Water Committee at its meeting on December 29th, the report by Mr. Robert Swan, on the new system of water supply. The report says that the ground along the Allegheny river was examined for a distance of fourteen miles, and the best location found to be on a plateau half a mile from Harmarville on the West Penn R. R., half a mile below the lower end of Hulings eddy and about the same distance from Nine-Mile island. The lowest point on the plateau is 241 feet above low water, and the highest 281.5 feet. It gives a range of territory sufficient for reservoirs with a capacity for 300,000,000 gallons. Borings made, show the ground for 240 feet above low-water mark to be clay mixed with fine gravel, and for 50 feet below that to be solid gravel.

The plan proposed provides for two reservoirs, divided by a partition bank. The banks are to be 25 feet wide on top, exclusive of puddle and brick paving; the top to be at an elevation of 278.5 feet above low water, the flow-line 273.5, and the bottom 248.5. The reservoir will be lined with 2 feet of puddled clay, with a brick pavement 5 inches thick on the bottom and 7 inches thick on the sides; the brick to be laid in hydraulic cement and to be surmounted by stone coping 4 feet wide and 1 foot thick. The size of the large reservoir at the flow line will be 667.2 feet long and 555.2 wide, and its capacity will be 57,457,552 gallons; the small reservoir will be 567.2 feet long and 555.2 wide, with a capacity of 48,014,836 gallons, a total of 105,472,388 gallons.

The rising main will be 4,000 feet long and can be laid almost wholly along country roads to avoid paying for the right of way. The distance from the reservoir to the present 36-inch main, at Penny and Williams streets, is almost nine miles. For much of this distance roads and streets can be used, but some right of way must be secured. Until the reservoirs are constructed, a work of time, the rising main can be used as a stand-pipe, and the city supplied earlier than if the whole system had to be built first.

In making estimates for the delivery main two systems were considered, one of cast-iron pipe and the other of steel pipe. Cast-iron, with calculations based on the delivery of 16,000,000 gallons every twelve hours, would require two 48-inch mains. This would take 36,000 tons of iron at $32 a ton, making $1,152,000; for hauling, laying, etc., $237,560; 12 stop-gates, $14,400; right of way (estimated), $50,000. Total for the cast-iron system of delivery mains, $1,454,000. By using riveted steel tubes a single line of 60-inch mains would be sufficient to deliver the 16,000,000 gallons every twelve hours. Its weight would be 18,141,309 pounds, at 4½ cents, amounting to $8,6358,90; hauling, laying, etc., $118,800; 50 man-holes, $1,250; six 60 inch gates, $10,800; right of way, $50,000. Total for the steel system, $997,208.90, or $456,791.10 less than for cast-iron.

The rising main will be 2,600 feet long, of 50-inch steel tubing, and the intake pipe 1,400 feet long, of 60-inch cast-iron pipe. The property contains 36.06 acres, and it is recommended that nine acres across the road be purchased as a dumping-ground for excavations arising in building. The engines and pump-house will be on the river bank opposite Nine-Mile island, half a mile from the reservoir and 1,100 feet from where the water is taken from the river. It is proposed to erect two engines of 8,000,000 gallons daily capacity each, and when the new system is in working order take the old engines up and add them to the plant. The estimates of the total cost are as follows:

Reservoirs	$ 679,091.85
Pump-house and engines	342,000.00
Intake pipe	34,680.00
Rising main	46,784.75
Delivery main	997,208.90
Total	$2,099,765 50
Add 10 per cent. for incidentals	209,976 55
Total cost of steel-tube system	$2,309,742.05

City Engineer Ehlers stated that if he was wealthy enough to give the guarantees he would agree to do the work at the estimates. The report was sent to Council without recommendation.

WATER SUPPLY OF DENVER, COL.—The ditch which furnishes water to the city is owned by the Platte Water Company, the members of which company are city officials and ex-city officials, who hold the stock in trust, the Mayor holding the controlling interest. The company was thus organized to keep vested in the company the priority water rights which were vested in the Platte Ditch Water Co. at the time of its organization in 1860. In 1883 the ditch passed into the city's control, but if the absolute change in ownership were made the priority title to water would cease to exist, and for this reason the stock was placed in trust of gentlemen who perpetuate the former company. The city's contract with the ditch will expire next spring, and the contract for a supply of water perhaps be renewed. President, J. E. Bates; Secretary, James T. Smith.

NEWS OF THE WEEK.

Contracting.

Water-Works.—Bassett Bros., of Buffalo, N. Y., have been awarded the contract for the water-works at Steuben.

The Tennessee Range and Manufacturing Co., of Nashville, Tenn., has been awarded the contract for the water-works at Lebanon.

Street Work.—At Chicago, Ill., special assessments will be made at once for the purpose of paving 31 streets next season.

At Little Rock, Ark., the citizens are trying to organize an improvement district to pave Main street from Markham to 5th street.

City Work.—During the past year Kalamazoo, Mich., has expended $34,000 on water mains, paving, sewers etc., and $120,000 on public buildings. The total for improvements was $615,000, against $526,000 in 1885. This year's building operations are estimated to amount to about $500,000.

The Edisto Construction Co. has been incorporated in South Carolina by John Harlin, Charles H. Drayton, Moses Dolby, Julian Mitchell and others, for the purpose of constructing railroads.

Rock Drills.—The Rand Drill Co., of 23 Park Place, N. Y., proposes to publish, from the Patent Office drawings, a series of illustrations showing the various designs for patented percussion rock drills. The purpose is to illustrate the work done in this direction by one company, and to save others from re-inventing a similar device.

Hoisting Apparatus.—The Lake Shore & Michigan Southern R. R. Co. has awarded a contract to the Brown Hoisting & Conveying Co., of Cleveland, O., for the erection of extensive hoisting and conveying apparatus at the ore docks at Ashtabula. The work will be done during the winter so as to have the facilities for an extensive business ready next spring.

Boiler.—The following proposals have been received by the Light-House Board, Washington, D. C., for a boiler for the tender "*Laurel*": T. & H. Smith, Jersey City, N. J., $4,825; H. A. Ramsay & Son, Baltimore, Md., $3,949; Columbian Iron Works & Dry Dock Co., Baltimore, Md., $4,200; E. J. Codd & Co., Baltimore, Md., $5,575; Pusey & Jones, Wilmington, Del., $6,600; John H. Dialogue, Camden, N. J., $7,900.

Dredging and Removing Rock.—The following proposals were opened January 3rd, by Lieut. Col. Elliott U. S. Engineer Office, Newport, R. I.: Dredging in Great Harbor, Wood's Holl, Mass., Frank Pidgeon Dredging Co., New York City, $1.10 per cubic yard; Hartford Dredging Co., Hartford, Conn., $1.33.—Removing rock in Lone Rock channel, Wood's Holl, Mass., George W. Townsend, Boston, Mass., $118; Hiram W. Phillips, Quincy Point, Mass., $285; Charles E. Davis, Wood's Holl, Mass., $375; Frank Pidgeon Dredging Co., New York City, $575.

Garbage Removal.—The City Works Department, Brooklyn, N. Y., has executed the contracts with Henry Berau and Andrew Wessel for the removal of garbage and the removal of dead animals and offal respectively. The contracts are for five years and run from January 1st. Mr. Berau will begin work under the third method proposed, namely, collecting the stuff and removing it one mile outside the city; his bid for this was as fol-

lows, First year, $75,000; second year, $65,000; third year, $60,000; fourth year, $60,000; fifth year, $60,000. If the Commissioner of City Works finds that this method will not work well, he will have Berau take the garbage out to sea or burn it. Berau has works at Fireman's island, Queens county, to which he will take the garbage under the third method. Wessel's contract is for $800 a year. He now has the night soil contract for the Health Department.

Water Pipe.—The following proposals were opened December 29, by the Commissioner of Public Works, Chicago, Ill., for 3,600 tons of cast-iron water pipe; the prices are for 450 pieces of 24-inch, 1,000 of 16-inch 200 of 12-inch; 3,000 of 8-inch; 5,000 of 6-inch; and 500 of 4-inch respectively: Lake Shore Foundry $30.95 per ton for all sizes; Shickle, Harrison & Howard, $33.40; Dennis Long & Co., $33.47; Cincinnati & Newport Iron & Pipe Co., $33.60; McNeal Pipe and Foundry Co., $33.50, $34.25, $34.75, $35, $35.25, $36.60; Buffalo Cast-iron Pipe Co., $28, $28.75, $28.75, no bids; A. D. Woods & Co, $30.80 for 24, 16 and 12-inch. The contract was awarded to the Lake Shore Foundry at $111,342.73 for 3,597.5 tons.

Revetment.—The following proposals have been received by Lieut. Col. O. M. Poe, U. S. Engineer Office, Detroit, Mich., for revetment construction at St. Clair ship canal; Augustus J. Dupuis, Detroit, Mich., $5.87 per lineal foot; Candler Bros., Detroit, $7.85; Schwarz & Berner, Green Bay, Wis., $8.12; Stang & Gillmore, Lorain, O., $8.12; Luther E. Allen, Charlevoix, Mich., $9.86; R. J. Cram, Detroit, Mich., $10; Henry M. Youmans, East Saginaw, Mich., $12; Hubbell & Keldon, Detroit, Mich., $14.50.

The Bucyrus Construction Co., of Bucyrus, O., has made proposals to contract for the great works to be undertaken for the drainage of the city and valley of Mexico. For over a year the work has been carried on by the authorities, but they recently determined to let contracts for the completion, and have appointed a commission to enter into a contract with some responsible company. Five companies have submitted proposals, two American, one Mexican, one English and one French company. Señor Pedro Gallardo, president of the commission; and Señor Jose Arce of the firm of J. Arce & Co., of the city of Mexico, the representative in Mexico for the Bucyrus company, have been in Cleveland, O., recently, to negotiate with the company.

Dredging.—The following proposals have been received by Gen. Wm. F. Smith, U. S. Engineer Office, Wilmington, Del.: *Nanticoke River*; Thomas P. Morgan, Washington, D. C., 12 cents per cubic yard. Frank C. Somers, Philadelphia, Pa., 11.75 cents. American Dredging Co., Philadelphia, Pa., 16.5 cents. George W. Parsons, Salisbury, Md., 18.5 cents (deposit material through shute 30 feet long behind existing dredge bank or on wharves); 20.5 cents (deposit material through shute 80 feet, or less, to 30 feet).—*St. Jones River*; American Dredging Co., Philadelphia, Pa., 12 cents. Frank C. Somers, Philadelphia, Pa., 14.75 cents. Thomas Draper, Dover, Del., 16 cents. National Dredging Co., Wilmington, Del., 16.9 cents. Atlas Dredging Co., Wilmington, Del., 17 cents. Thomas P. Morgan, Washington, D. C., 18 cents.

The following proposals were opened January 4th by Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C., for dredging in Cape Fear river; amount of contract, $50,000; (proposals were first opened on November 9th, and rejected, the lowest, 14.9 cents, being too high): Atlas Dredging Co., Wilmington, Del., 9 cents per cubic yard, in scow, (former bid 14.9 cents); Rittenhouse Moore, Mobile, Ala., 9 cents (15.5); National Dredging Co., Wilmington, Del., 10¾ (15.5); American Dredging Co., Philadelphia, Pa., 10.5 cents (15.5); P. Sanford Ross, Jersey City, N. J., 11.9 cents (15.2); Morris & Cummings, New York City, 13 cents (15.75); George C. Fobes & Co., Baltimore, Md., 14 cents (16.5).

Rolling Mills.—The North Chicago Rolling Mill Co. is making extensive improvements to their plant at Bay View, a suburb of Milwaukee, Wis. Owing to their rapidly increasing orders from all parts of the country, they will start blast furnace No. 3, which has been idle for some time, within a few days, which will increase the output of the work by 100 tons of pig-iron daily; when this furnace is running the entire plant will be in full operation. The company is also building a new 21-inch mill for Bay View, which will be put in operation about March 1, and will increase the output of manufactured iron and steel about 3,000 tons a month, and will give employment to about 300 additional men. The company is now making at its Bay View works about 1,200 kegs of nails daily, and 13,000 tons of manufactured iron and steel monthly. Francis W. Henton is the resident manager at Milwaukee. The rolling mills at North Chicago, which have been closed for repairs will start up again shortly and run to their full capacity. At a meeting of the company held at the office, 17 Metropolitan block, Chicago, on December 31st, it was decided to increase the capital stock $1,000,000; to be issued soon after March 1. This will make the total capital $6,000,000.

Oil Refinery.—The Standard Oil Co., of New York, will erect an oil refinery at Franklin, Pa., to cost some $250,000. Work will be commenced at once and completed by May 1.

Dry Dock.—The Milwaukee Shipyard Co. has paid $35,000 for a location near Sixth street bridge, Milwaukee, Wis., and will soon commence the construction of a large dry dock, to cost between $50,000 and $75,000.

Post Office.—Plans are being prepared in the office of the Supervising Architect, Washington, D. C., for the new government building, to be erected at Oshkosh, Wis., in the spring. The site which has been selected and donated by that city will cost some $13,000. The building will cost about $100,000.

Warehouse.—Robert Low, 141 Dearborn street, Chicago, will erect a fine warehouse at 230 to 236 Frank'in street, Chicago, to cost about $150,000, seven stories, 82x125 feet, pressed brick and stone, structural iron, elevators, plate glass, steam heat. Messrs. J. M. Van Osdel & Co., architects, 41 Clarke street, are engaged on the plans.

Club House.—The Standard Club are about to erect a new club house on the southeast corner of Twenty-fourth street and Michigan boulevard, Chicago, to cost $150,000. Plans have been made by architects Adler & Sullivan, 58 Borden block. Four stories, stone, structural iron, elevator, plate and art glass, hardwood interior, tile flooring, electric apparatus, etc. Contracts not let.

Bridge Contract.—Messrs. W. G. Coolidge & Co., bridge builders, engineers and contractors, 36 Montauk block, Chicago, have been awarded the contract for the new iron draw bridge, to be built over the Chicago & Northwestern R. R. Co., over the Chicago river, at Clybourn avenue. It will be a double track bridge, 176 feet in length, swinging on a pivot. It will be a very substantial and well designed structure.

Iron Works.—The Vulcan Iron Works, 86 North Clinton street, Chicago, are daily receiving a large number of orders from all parts of the country. They have an order from the Colorado Midland R. R. Co., and the Atchison, Topeka & Santa Fé R. R. Co., for pile drivers, and a steam pile driver for McGowan & Son, Astoria, Oregon. They have also the contract for furnishing the engine and machinery for the new State street bridge, Chicago.

The New York Subway Construction Company held a business meeting on January 4th, and further arrangements were made to have everything ready for the resumption of work in March. The Board of Engineers which will examine into materials and make the suggestions, has been completed in so far that Engineer Beckwith, of the Metropolitan Telephone Company, has been chosen chief engineer, and Engineers Davis and Thomson, consulting engineers.

Steam Heating Apparatus.—The following proposals have been received by the Supervising Architect, Treasury Department, Washington, D. C., for steam heating apparatus for the public building at Oxford, Miss., Wm. Kirkup & Sons, Cincinnati, O., $4,321; Samuel J. Pope & Co., Chicago, $4,697; Hayward & Co., Baltimore, Md. $4,773; Walworth Manufacturing Co., Boston, Mass., $5,500.

Cement, Stone, Etc.—The following proposals were opened January 4th, at the Navy Pay Office, State street, New York City,: *Cement*, Johnson & Wilson, $2.15 per barrel, Portland; Howard Fleming, $2.34, Portland; Sinclair & Babson, $2.35, Portland; James J. Donovan, $2.70, Portland; $1.50, Rosendale. Contract awarded to Johnson & Wilson for Portland: not awarded for Rosendale, the bid being over the estimate.—*Broken Stone and Sand*, Thomas Quillan, $1.50, 90 cents, respectively; A. J. Howell, $1.97, 79 cents; M. F. Fitzsimmons, $1.95, 90 cents; E. J. McKeever, $1.95, $1; Thomas Hayden, $2.19, 99 cents; J. A. Bouker, $2.30, 75 cents; B. G. Bailey, $2.50, $1. Contracts awarded to T. Quillan for stone, and J. A. Bouker for sand.—*Granite*, W. S. White, granite, $1.29 per cubic foot; granite dressing, $1.05 per cubic foot; Nolan & Son, $1.58, 93 cents; Booth Bros., $1.74, $1.10; Mt. Waldo Granite Works, $2.25, no bid; B. G. Bailey, $2.50, no bid: C. F. Stall, $2.50, no bid; Bodwell Granite Co., $2.77, no bid; Thomas. B. Dilion, no bid, $1.73; John Brew, no bid, $1.85 Contracts awarded to W. S. White for granite; not awarded for granite dressing, the bid being over the estimate.—*Timber*, J. W. Dunfee, $1,056, South Brooklyn Saw Mill Co., $1,140.44; J. C. Staples, $1,187.16; Dannatt & Pell, $1,945.90. Contract not awarded, the bid being over the estimate.—*Gaskets, Rope and Iron*, John Swan & Co., gasket, $299; rope, $210, iron, etc., $192; James J. Donovan, $335.50, $191. $223.40; R. A. Robbins, $366.85, $186.90, $206; Thomas F. Stevenson, $391, $227.50, $272,34. F. M. Smith, no bid, $187.32, $216.25; J. W. Saper, $177.57 (iron); John A. Roebling Sons Co., $193.50 (rope). Contracts were awarded to J. Swan & Co., for gasket, and to J. W. Saper for iron, etc.; contract for rope not awarded, the bids being over the estimate.

Cable.—The contract for the wire cable for the Vine street cable railroad has been awarded to a St. Louis firm by the Cincinnati Street Railroad Co. It will be eight miles in length and will weigh about 55 tons.

Messrs. Merchant & Co.—The Chicago branch of the firm of Messrs. Merchant & Co., of Philadelphia, manufacturers of roofing plates, has been transferred from 182-183 E. Kinzie street to 202 Lake avenue, the change having been necessitated by extension of the firm's business. Mr. V. Le Luray, who has been for three years manager of the New York branch, left for London on January 1st, to assume the position of general manager of the London office recently opened.

Railroad Work.—John Brown, of Mohawk, N. Y., has been awarded the contract for constructing three sections of road from Rockport to Freeport, Ill.

Mr. Ratican, railroad contractor, of Dallas, Tex., will send in proposals for extensions of the Missouri Pacific R. R. system, from Dallas to Waco, from Bastrop to Houston, and from Dangerfield to Texarkana.

J. M. Ross, railroad contractor, is estimating on the cost of constructing a railroad between Duluth, Minn., and Winnepeg, Manitoba; he has been in Winnepeg recently.

Contracts have been signed by Vice-President Smith at Nashville, Tenn., for the construction of the Louisville & Nashville R. R. from St. Joseph to Florence.

The Chicago, Milwaukee & St. Paul R. R. Co. will erect machine shops at Austin, Minn.

City Works of Cleveland, O.—The sewer builders and plumbers have been protesting against the enforcement by the Board of Health of the rules laid down in the new ordinance prescribing the manner in which plumbing and house drainage work is to be executed. Health Officer Ashmun called a meeting and the rules were gone over carefully. Entire satisfaction was felt concerning all of them but two, which are as follows:—

Section 1—That no part of the work of plumbing and house drainage shall be covered or concealed in any way until after it has been examined by an inspector of the Board of Health, and notice must be sent to the office of the board when the work is sufficiently advanced for inspection.

Rule 9—Any house drain or house sewer put in and covered without due notice to the Health Department must be uncovered for inspection at the direction of the inspector.

The sewer builders and plumbers, without exception, claimed that to leave the trenches open until an inspector could look at the work would make every job cost them 25 per cent. more than at present, by reason of the delay that would be occasioned. They claimed that the plan would operate successfully only in case an inspector watched every part of the work as it was done. This would necessitate several hundred inspectors. It was stated also that it was often impossible to keep the trenches open, owing to the nature of the soil. Foundations of buildings, building piers, etc., would also be endangered.

One of the most important subjects considered by the committee on legislation at their recent meeting was the abolishment of the contract system in cleaning the streets, catch-basins, etc. One of the strongest arguments used during the discussion was that many poor men, now supported by the infirmary, would receive employment from the city if the Street Commissioner did the work. The increase in pay of the street department would therefore be balanced by the decrease of the expense involved in maintaining the infirmary. From 1873 to 1877, inclusive, which was previous to letting the work by contract, the average street expense per year was $88,645.50. The average expense of conducting the infirmary during the same time was $64,550.76 The contract system for cleaning both paved and unpaved streets existed between 1877 and 1884. The average expense per year during these six years was $89,609.61. The average infirmary expense for the same time was $45,009.70. In 1884 the contracts of Warren Farr, for cleaning paved streets only, began. During the three years since that time the average expense per year has been $93,813.87. The average infirmary expense for the same time was $55,758.75. In the above calculation the street expense for 1882 to 1886 includes the amount paid for sidewalks laid by the city, which, if deducted, would somewhat diminish the street expense for those years. Previous to 1882 the sidewalk account was separate. The figures show that during the period when the street work was done under the contract system, the street expense was less per year than during the preceding five years by $17,035. 89, while, for the same period, the infirmary expense was diminished per year by $19,541.06. They show also that during the three years when contract work was restricted to cleaning paved streets, the street expense was increased per year by $23,907.26; while, for the same period, the infirmary expense was increased per year by $10,749.05.

Proposals Open.

Filter Plant.—Not less than 20,000,000 gallons daily capacity delivered in Troy Hill reservoir during the worst state of the river; at River avenue pumping station. Office of the Comptroller, Allegheny, Pa. January 10.

Bridge Work.—Piers for Grand avenue bridge approach; iron work for north viaduct approach; removing wooden bridge at Birchen street and erecting an iron bridge in its place. Henry Flad, President of Board of Public Works, St. Louis, Mo. January 11.

Sewer.—300 feet of 18-inch and 750 feet of 15-inch salt-glazed drain pipe, 3 receiving basins, 7 manholes. Street Commissioner's Office, Newark, N. J. January 12.

Stone and Brick Work.—For public buildings at Keokuk, Ia., and Lexington, Ky.; separate bids. Office of the Supervising Architect, Treasury Department, Washington, D. C. January 12.

Building.—Repairs, alterations and construction at the Truant Home. Department of City Works, Brooklyn, N. Y. January 12.

Tunnel.—Between Cambridge and Cooperstown, 1,600 feet long, and approaches. Cleveland & Marietta R. R. Co., Cambridge, O. January 12.

Stone, Cement, Sand and Pipe.—3,328 cubic yards crushed and screened or hand-broken limestone, 8,544 bags cement, 832 cubic yards sand, and 37,021 feet of 6-inch drain pipe; for the Vine street cable road; engineer, H. M. Lane, 233 W. Fourth street, Cincinnati Street Railroad Co., Cincinnati, O. January 12.

Engines and Boilers.—Two 150-H. P. engines and foundations; three internally fired steel boilers. Daniel M. Fox, Superintendent of U. S. Mint, Philadelphia, Pa. January 15.

Drainage.—Renewing drainage system at Naval Hospital, Norfolk, Va. Bureau of Medicine & Surgery, Navy Department, Washington, D. C. January 16.

Railroad.—Grading, ties, bridges, ballasting and track laying, from Mt. Forrest, Mich., to Gladwin, 20 miles. J. D. Hawks, Chief Engineer, S. B. & N. W. R. R., Detroit, Mich. January 17.

Street Work.—Grading, curbing, crossings, flagging guttering, macadamizing, culverts, drains and retaining walls. Board of Public Affairs, Cincinnati, O. January 19.

Sugar Machinery.—A diffusion battery and appliances for experimenting with the manufacture of sugar in Louisiana, U. S. Department of Agriculture, Washington, D. C. January 20.

Water-Works.—At Junction City. Reservoir, well, boiler house, machinery and five miles of mains. Engineer, J. B. Johnson, Washington University, St. Louis, Mo. City Clerk, Junction City, Kan. January 24.

School House.—Brick building. Competitive plans received by the Board of Education, Omaha, Neb., until Febuary 1.

Water-Works.—Complete system, reservoir or stand-pipe, for population of 50,000 and fire protection. E. A. Sturges, mayor, Waco, Tex. April 23.

Railroads, Bridges and Canals.

Pipe Subway and Drain.—Sylvanus D. Locke, of Hoosick Falls, N. Y., has patented a system of subgutters or subways, built under the street gutters and provided with brackets for supporting wires and pipes; the cover is curved and perforated, and the gutter is intended to serve as a drain for removing snow from the streets.

Montana Central R. R.—Grading is nearly completed on the line from Helena to Great Falls, 97 miles. In the Prickly Pear and Missouri cañons there are five tunnels under construction, three being already completed. Their lengths are respectively 573, 362, 570, 172 and 813 feet; total 2,490.

Steel Rail Mill.—Carnegie Bros., of Pittsburg, Pa., have decided to erect a new steel rail mill at Braddock, work on which will be commenced at once. The plant will cost $1,000,000, and the works will then have a capacity of 400,000 tons of rails per annum, or nearly half the production of the company.

The Ries Electric Railroad Manufacturing Co. has been incorporated at Portland, Me., to equip electric railroads, and manufacture electric appliances and apparatus. President, Robert F. Straine; Treasurer, H. H. Honore, Jr.; Secretary, Philip T. Nickerson. Capital stock, $1,000,000.

Poughkeepsie Bridge.—Work is steadily progressing. The following board has been elected: H. C. Gibson, I. V. Williamson, A. M. Moore, Morton McMichael, of Philadelphia; A. Brock, H. McCormick, of Lebanon, Pa.; W. Van Benthuysen, P. W. Gallaudet, J. C. Drayton, S. W. Knevals, of New York City; J. I. Platt, E. Elsworth, Poughkeepsie, N. Y.; J. H. Appleton, Springfield, Mass.

Bridge Companies.—The East Birmingham Bridge Co. has been incorporated at Pittsburg, Pa., to build a bridge across the Monongahela river. The directors are E. S. Kennedy, J. Delaney, P. Foley, H. R. O'Conner and H. Meyer. Money has been subscribed for the cost of the bridge, and work well be commenced as soon as the weather permits.

A company with a capital stock of $50,000 has been organized to build a highway bridge over the Delaware between Lambertville, N. J., and New Hope, Pa.

Railroads in the Balkan.—The junction of the Turkish and Servian railroads will be a matter of great importance to British trade, as the length of the railroad from Salonica to the Servian frontier is only about 200 miles and to Nissa about 275; at present the cheapest route for English freight to Servia is by way of Fiume and Sissek, which involves an inland transport from Fiume to Belgrade of about 425 miles. It is hoped that before long the Bulgarian government will build the line between the Roumelian R. R. and the Serbish line to Pirot.

A Russian Canal.—Russia has negotiated with the Hersents, of Paris, for a loan of $14,550,000 for the construction of a canal from the eastern extremity of the Gulf of Perekop, in the Black sea, across the neck of land joining the Crimea to the mainland to the Sea of Azov, in order to afford a direct water route from the river Don to the Black sea. The proposed route would be shorter, more direct and much easier from the mouth of the Don to either Odessa, the mouths of the Danube Sebastopol, or the Bosphorus than the present one by way of the strait of Kertch, which is both round-about and difficult.

Elevated Sidewalks.—M. J. Coyne, of South Halstead street, Chicago, has invented a system of elevated sidewalks to relieve blockades and facilitate pedestrian traffic. The walk would be carried on iron columns, with regular bridge spans at street crossings, and would be about 6 feet wide and about 15 feet above the street. The terminal approaches will be inclined planes, and there will be stairways, 4 feet wide, at each street corner; at these corners the walk will be 12 feet square. Mr. Coyne thinks it will take 75 per cent. of the passengers from the sidewalks, and that retail stores will build platforms from the elevated walk to afford access to the second floor.

Paris Metropolitan R. R.—Under the latest project for a metropolitan railroad for Paris, it is to have a total length of 26.6 miles of two classes, "definite and eventual." Of the first 5.73 miles will be in viaduct 3.93 miles in cuttings, and 12.55 miles in tunnels. The total estimated cost is $57,000,000, and the guaranteed interest $2,400,000; of this the great railroad companies are pledged for $1,000,000, the city of Paris for $460,000, and the French Government, $240,000.

Union Elevated R. R.—The City Works Department, Brooklyn, N. Y., has approved the plans of the Union Elevated R. R. Co. for its structure in Hudson, Flatbush and Fifth avenues, to Twenty-seventh street. Approval was withheld from the plans for the curve connecting Hudson and Flatbush avenues, where the route crosses Fulton street, on the ground that the curve was too sharp and the plans were not clear. It was ordered by the commissioner that permits be granted for opening the streets from time to time as the company applied for them. It is expected that work will begin in Fifth avenue, and connections will be made with the Brooklyn, Bath & West End R. R. and the Prospect Park & Coney Island R. R. before spring. The structure in Hudson avenue will connect with the Brooklyn Elevated R. R. now in operation. The same men are interested in the two companies.

Arthur Kill Bridge.—The U. S. Board of Engineers has reported that the bridge, as proposed, which has a clear opening of 200 feet for the large tows made up of several vessels, would be a serious obstruction to navigation, and that a pier in the middle of the Kill should under no circumstances be allowed; its height of 34 feet 8 inches above the water is also insufficient. The Board recommends a bridge at the site proposed, the channel piece of whose east pier shall be on the Staten island bulkhead or shore line, and whose channel span shall give a clear opening of 450 feet; the span west to be a draw span, giving 125 feet clear opening, the lowest parts of these spans being 50 feet above mean high water. The foundations of the pier should be so arranged as to admit future deepening of the Kill to 20 feet. Such a bridge will be an obstruction and an inconvenience, the report says, but will not in any serious degree increase the cost of transportation. It involves some increase of cost to the railroad company, but no more than it should bear rather than infringe on the pre-existing rights of navigation. A drawbridge on the proposed Buckwheat island site, the report says, would be impracticable for the reason that the channel has but 6 feet of water on one side and on the other side is narrower than at the site recommended.

The Tuscaloosa Railroad & Improvement Co. has been incorporated at Tuscaloosa, Ala.

Mississippi River Bridge.—The bridge across the Mississippi at Fort Madison, Ia., for the A. T. & S. F. R. R., has been located by Octave Chanute, M. Am. Soc. C. E., of Kansas City, Mo. There will be two spans of 150 feet, two (covered by the draw) of 200 feet, three of 275 feet, and two of 200 feet; its total length will be 1,925 feet with a trestle approach of 2,000 feet on the east side. The track will be 13.3 feet above high water. Boring has been commenced for the pier foundations.

New St. Louis Bridge.—The Board of U. S. Eng'rs. has been taking evidence on the comparative merits of a high and low level for the new bridge across the Mississippi. Col. Flad, city engineer, spoke strongly in favor of a high-level bridge, as a draw-bridge would practically blockade the river traffic. He estimated the cost at approximately $2,000,000 for a high level cantilever bridge with three spans of 500 feet, and $1,800,000 for a low-level bridge.

Highway Bridge.—Chief-Engineer Artingstall, of Chicago, has prepared another estimate for the erection of a bridge across the river between Fourteenth and Maxwell streets for the consideration of the Council. The cost of a single roadway bridge, with foundations, end piers, protections, and approaches, will be $60,000; 300 feet of viaduct over railroad tracks $37,500; 1,570 feet of approaches, $47,100; total, $144,600. In addition to this, it will be necessary to condemn 15,240 square feet of land on the west side of the river and 29,280 square feet on the east side for the approaches.

New Railroads and Extensions—Oregon Pacific R. R. Work is progressing on the extension, the grading is completed from Albany to the Santam river.——Old Colony R. R. The line will be built to Easton and Mansfield, Mass.——California Southern R. R. Grading is progressing on the San Bernardino & Los Angeles line; 40 miles to be built in 60 days.——New York & Omaha R. R. Right of way is being secured near Findlay, O., where the shops will be located.——Cincinnati, Indianapolis, St. Louis & Chicago R. R. The survey has been commenced for the extension from Columbus to the Indiana & Illinois Southern R. R. at Switz City, Ind.——Cape Breton & Nova Scotia R. R. The line will reach Sydney and Louisberg, with a branch to North Sydney.——A railroad is to be built from Eufaula, Ala., to St. Andrew's Bay.——A railroad is to be built from Cannelton, Ind., to Gentryville; Morris McDonald, of New Albany, Ind., is interested.

New Railroad Companies—Cape Girardeau & Grand Tower R. R. Co.; in Illinois; Wm. Brown, St. Louis, Mo., and others; capital stock, $300,000; office at East Cape Girardeau, Ill.——St. Louis & Northeastern R. R. Co.; from East St. Louis to the Illinois eastern state line in Vermillion county; capital stock, $4,000,000.——San Bernardino & San Diego R. R. Co.; in California; C. W. Smith, Vice-President of the A. T. & S. F. R. R Co., is interested.——Tennessee Midland R.R. Co.; from Memphis to the Virginia state line in Hancock county; J. B. Pace, R. H. Temple and others.——Mount Vernon & Wabash R. R. Co.; in Indiana; C. A. Quitland, G. V. Menzies and others; capital stock, $100,000.——Chicago & Southeastern R. R. Co.; O. G. Fessenden, J. P. Gardner, and others, of Chicago; capital stock, $100,000.——Cumberland Valley & Unaka R. R. Co.; from Carthage, Tenn., to North Carolina; 200 miles; W. Breyfogle, Louisville, Ky., R. G. Dunn, New York City; capital stock, $3,000,000.——Hartford & Harlem R. R. Co.; the company has been reorganized; Lewis M. Brown, New York City, C. Fairchild, Boston, and others.

The Proposed River and Harbor Bill.—The River and Harbor Committee will shortly report a bill appropriating about $7,500,000 for improvements in rivers and harbors. The amount estimated as required was $30,000,000. In New York State the chief items "cut" by the committee, according to last accounts, are—For Buffalo, from $250,000 to $62,000; Buttermilk channel, from $50,000 to $15,000; Oswego, from $80,000 to $20,000. The other points generally suffer in about the same percentage. While the engineers recommended $500,000 for New York harbor, only $100,000 is allowed, though some further concessions may be made. The harbors of Connecticut will receive about $50,000 in all: New Jersey gets $15,000 for Raritan harbor. New York rivers get $32,500 and Jersey rivers, $32,500. The appropriations for the Pennsylvania and Delaware rivers and harbors, as finally included in the bill by the committee are as follows: Delaware river, $125,000, estimate $500,000; Schuylkill, $10,000, estimate $50,000; Delaware breakwater, $50,000, estimate $200,000; Marcus Hook, $7,500, estimate $75,000; New Castle ice harbor, $2,500, estimate $15,000; Wilmington, Del., $15,000, estimate $75,000; Erie harbor, $12,000; estimate $46,620; Hen's island dam, $28,000, estimate $115,500; Allegheny river, 15,000, estimates $40,000; Ohio river, $175,000, estimate $500,000.

Tunneling the Rocky Mountains.—There is a project on foot to tunnel the Rockies under Gray's Peak, which rises 14,441 feet above sea level. By tunneling for 25,000 feet at 4,441 below the summit direct communication would be opened between the valleys on the Atlantic and Pacific slopes.

A Railroad for China.—The first road to be built by the China Improvement Co. is to be between Tientsin and Taku, 37 miles. In summer there is water communication between the two cities by the Peiho river, but during the winter, when the river is frozen, all trade is suspended. The survey is to be made at once and construction will be commenced in the spring.

Electric Motors.—Some of the cross-town street railroads in New York City are to be operated by electric motors. Much interest is felt in the results of the trials, which will take place shortly, as in the event of the results being satisfactory the motors may be adopted for the longer lines, and thus enable them to compete with the elevated railroads.

The Meigs Elevated R. R.—George Stark, the civil engineer appointed by the Board of Railroad Commissioners to inspect the experimental section at East Cambrige, Mass., has reported that the track and equipment are of ample strength and well adapted for their purpose.

Nashville Canal—A canal is proposed at Nashville, Tenn., to run from the upper island in Cumberland river through Shelby's bottom. The plan is to give the water in the canal a fall sufficient to operate several manufactories. The proposed line has many natural advantages, such as would render the cost of construction much cheaper than such work usually costs, and the removal of the dirt necessary for the construction of the canal could be advantageously used in constructing a levee.

Mileage of Indian & South American Railroads.—Bombay, Baroda & Central India R. R., 461. Bombay, Baroda & Rajputana-Malwa R. R., 4,411. Eastern Bengal R. R., 303. East Indian R. R., 1,515. Great Indian Peninsula R. R., 1,504. Madras R. R., 861. Oude & Rohilkund R. R., 680. Scinde, Punjaub & Delhi R. R., 705. South Indian R. R., 654.

Bahia & San Francisco R. R., 76.75. Buenos Ayres & Ensenada Port R. R., 35. Buenos Ayres Great Southern R. R., 6?0. Buenos Ayres Northern R. R., 20. Buenos Ayres & Rosario R. R., 190. Central Argentine R. R., 246.3. Central Uruguay of Monte Video R. R., 172. East Argentine R. R., 99. Lima R. R., 17.5. Recife & San Francisco Pernambuco R. R., 77.5.

New Dredging Apparatus.—A. B. Bowers, San Francisco, Cal., has patented a hydraulic dredging apparatus consisting of a telescopic suction-pipe, with a hollow rotary excavator at its lower end. The excavator is provided with detachable cutters and delivers the spoil inward through itself to the pipe; it is arranged to work with a side feed and to swing in lateral planes, having devices to cut downward as the excavator is lowered at each swing, and other devices to cut the slices made by the side cutters. Fenders are provided to prevent the excavator from catching on obstructions, and the pipe and excavator are arranged to be drawn up above the bottom of the boat.

Wm. P. Lewis, Oroville, Cal., has invented a pneumatic dredging apparatus consisting of a vacuum chamber and a suction chamber composed of adjustably connected cylinders; with driving machinery. At the bottom of the suction chamber is a horizotal rotating wheel, fitted with cutters.

Street Railroad Tracks.—Mr. Augustine Wright, C. E., of Chicago, Ill., stated recently in the *Street Railroad Journal* that the tracks were not spread by the cars but by the heavily loaded teams turning off the track. Half the weight of the wagon and load must be lifted one inch—the height of the rail head—and the force is exerted with a leverage equal to the distance from the end of the tongue to the center of the front wheel. To prevent spreading of the stringers Mr. Wright uses four cast-iron knees on each tie, inside and outside of both stringers; the outside knees are 4 inches high with a base of 8 inches, and the inside knees 2 inches high with 4 inches base; the larger one is made of the same height as the stringer. These knees are spiked to the stringers and ties, which are spaced at 4 feet intervals, and weigh 2.6 and 7.75 pounds, respectively. He has never experienced trouble from the spikes working loose.

The Emerson System of Car Heating.—After some years experience on the Connecticut River R. R., Mr. James Emerson, of Willimansett, Conn., has brought his system to completion and success. It is a steam heating system, the steam being supplied from the locomotive and returning to the boiler by circulating pipes. To maintain the temperature when the engine is detached, there is a boiler carried under the car; and in case of the temperature being too high, the steam is turned into pipes running along the roof of the car. At present it is not thought practicable to heat more than 8 or 10 cars in a train from the engine. Experiments show that there is no danger to be apprehended from scalding in the event of a pipe bursting. The officials and employés of the road speak very highly of the efficiency of this system.

Street Railroads.—The Allegheny Rapid Transit Passenger Co. has been incorporated at Harrisburg, Pa., capital stock, $50,000.——The Citizens' Street Railroad Co., Memphis, Tenn., has gained its suit and will construct its lines at once.——The Classic City Street Railroad Co. has awarded the contract for construction to James G. Scott.——The Montague Street Railroad Co., Brooklyn, N. Y., has been incorporated, with a capital stock of $500,000; it will build a cable road from the City Hall to Wall Street ferry.——The Gozebic Street Railroad Co. has been incorporated by C. F. Dunbar and others at Hurley, Wis.; capital stock, $25,000.——The New Albany Cable Railroad Co. has been incorporated by C. N. Brockington and others, of New Albany, Ind.; capital stock, $100,000.——At Quincy, Mass., a street railroad is to be constructed to neighboring villages; cost about $50,000; length 5 miles; mechanical traction will be employed; W. L. Faxon is interested.——A local company will build a street railroad at Westfield, Mass., $6,000 have been raised towards the $20,000 needed.——Two new electric railroads are to be constructed at Scranton, Pa.——An electric railroad is to be introduced at Charlotte, N. C.——A street railroad is to be put down at Yonkers, N. Y.

Railroads for Montana.—Governor Hauser has been in negotiation with the Northern Pacific R. R. Co. for the construction of branches in Montana and Idaho. The contract for the Helena & Boulder Valley R. R. will be let from Butte at once. The work is now in active progress from Jefferson on the Wickes branch to Boneder, and will be completed by June. The Helena & Northern R. R. will be let on the 15th. This will connect the capital with the Drum Lummon mine, which is now turning out $200,000 per month with its 120-stamp mill. From this point the line will be extended to the Dearborn coal mines and beyond. The Bitter Root Valley branch will be built at once, connecting Helena with the Granite mine, which turns out $1,000,000 a year, and it will then be extended to the head of the Bitter Root valley. The Cœur d'Alene line of railroad and steamers will be completed in season for next year's active operations, connecting the great camps there with Helena, via the Northern Pacific R. R. The Helena & Red Mountain R. R. is now in active operation, having been turned over to the Northern Pacific, under a lease, as all of the others of these allied lines will be as they are completed. The Union Pacific will make large extensions of its branch system in Montana. Ten million of dollars will be disbursed in Montana during the next year in railway developments, and Helena will be the center of all the systems. The Billings, Clark's Fork & Cooke City R. R. Co. has executed a first mortgage to the Farmers' Loan and Trust Company, of New York, for $2,000,000. The definitely surveyed line of the route has been approved by the government, and commences at the town of Billings, and follows the Clark's Fork river to Cooke City, in Gallatin county, with a branch beginning at a point on the Clark's Fork river, thence up Rocky Fork to Red Lodge, also in Gallatin county.

Contractors Intelligence,

Engineering and Building Materials.

New York, January 6, 1887.

WHOLESALE PRICES.

IRON.

STRUCTURAL IRON.		
Angles	2.25c	@ 2.50c
" steel	2.40	@ 2.60
Tees	2.70	@ 2.90
Beams and channels, American	3.00	@
Tank plates	2.45	@ 2.60
Shell plates	2.70	@ 2.80
Steel plates, tank	2.90	@ 3.00
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black ..... Discount		37½
" galvanized ..... "		27½
Lap welded, black ..... "		55
" galvanized ..... "		37½
Boiler tubes		45
RAILS.		
Steel (large lots at mill)	$36.80	@ $37.00
Old rails	24.00	@ 25.50
Old rails, steel	22.00	@ 23.00
⅞ R. spikes	2.25c	@ 2.40c
T R. splice-plates	2.00	@ 2.10
R R. track bolts, square nuts	2.85	@ 3.00
Barb wire fencing, galvanized	3.85	@ 3.90
" " painted		4.00
Corrugated iron		
Nails		
Iron, per keg		2.15
Steel do.		2.30

METALS.

COPPER.		
Lake Superior	11.75	@
Other Brands	10.50	@ 11.00
LEAD.		
Com. Domestic	4.30	@ 4.35
Lead Pipe	.06¾c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.70	@ 5.60

BRICK.

Cargoes (afloat)		
Choice Brands	8.50	
Haverstraw ..... per M.	7.75	@ 8.25
Fishkill	7.50	@ 7.75
Up-River	7.25	@ 7.50
Jerseys	7 00	@ 7.2
Long Island		
Pale	4.75	@ 5.00
FRONTS.		
Croton, red	13.00	@ 15.00
" dark	13.00	@ 15.00
" brown	12.00	@ 14.00
Philadelphia pressed	28.00	@ 29.00
Trenton "	27.00	@ 28.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	80.00	@ 120.00
Fire brick	25.00	@ 55.00
American, No. 1	30.00	@ 35.00
" No. 2	25.00	@ 30.00

ASPHALT.

ROCK.		
French, per ton	$22.00	@ 25.00
German	15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.00

LIME.

Rocklock Cement Co.'s Ground	.80	
Rockland, common per bbl	1.00	
" finishing	1.20	
State, common	.85	@ .90
" finishing	1.05	@ 1.10
Kingston, ground	.90	
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.		0.95	@ 1.00
" " No. 2 "		0.75	@ 0.85
" " light drab "		0.80	@ 0.95
Berlin " in rough "		0.75	@ 1.00
Berea "			
Brown stone, Portland, Ct. "		1.00	@ 1.35
" Belleville, N. J.		0.75	@ 1.35
Granite, rough		0.45	@ 1.25
Common building stone per load		2.00	@ 3.00
Sidewalk stone, from 2½ to 6 ft. lengths, per lin. ft.		0.40	@ 3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd			$1.65

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement	$1.20	@ 1.25
BAETJER & MEYERSTEIN:		
Hanover Portland	$2.60	@ $2.65
BELLONI & CO.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25	@ 2.50
Fewen	2.25	@ 2.50
BROOKS, SHOOBRIDGE & CO.	2.45	@ 2.60
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40	@ 2.75
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50	@ 2.75
K. B. & S. " "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
HUDSON RIVER CEMENT CO. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
EMIL LENZ, New York.		
Stettin Portland	2.35	@ 2.55
Fire-proof	1.75	@ 1.95
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
NEW YORK CEMENT CO.:		
Rosendale	1.20	@ 1.25
N. Y. & ROSENDALE CEMENT CO.:		
Rosendale, "Bridge" brand	1.20	@ 1.25
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S. " "	2.25	@ 2.50
STANDARD CEMENT CO		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT CO.:		
English Portland	2.25	@ 2.40
German	2.00	@ 2.15
Standard	1.80	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT CO.:		
Akron "Star" brand	1.00	@ 1.10